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No. 100

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ERRATUM: In JPRS 77282, 30 January 1981, No. 80 of this series, page 51, please make the following correction, in the second abstract, "Submarines and Noise," in the third line change 10dB to read "to one-tenth of a decibel."

NATIONAL DEVELOPMENTS

INTENSIFICATION OF PARTY SUPPORT FOR SCIENCE URGED

Beijing GUANGMING RIBAO in Chinese 18 Apr 81 p 1

[Article: "The Entire Party Should Accord the Proper Importance to Science and Tehnology"]

[Text] The development of modern science and technology is currently an urgent and important task of the entire party. The central link in accomplishing this task is improvement of the entire party's awareness of science and technology and bringing science and technology's critical role in our country's socialistis modernization construction and social development fully into play.

Are science and technology really important? What role do they play in national economic development? Consider several facts: In agricultural production, in 1980 hybrid rice already was planted on more than 80 million mu nationwide and was giving an average increase in yield of 100 jin per mu, or a total increase in output of 7 billion jin nationwide. Comprehensive research into techniques for increasing output and their extensive application have enabled Henan Province to increase it wheat output by an average of more than 3.5 billion jin a year for the past several years. Primarily owing to effective popularization of the superior variety Lumian No 1, in addition to implementation of policy and relatively favorable climatic conditions, last year Shandong Province's total cotton output was more than two times larger than in 1979. In industrial production, because the Panzhihua Iron and Steel Company adopted the blast furnace technology, which was developed exclusively by this country, for refining vanadium-titanium magnetite ore, and utilized its comprehensively, it soon turned losses into profits; while in 1977 this enterprise lost more than 11 million yuan, by 1980 it was already paying more than 107 million yuan in profits to the higher levels. Light industry and the textile industry are making use of more than 460 scientific research results and have energetically promoted the production of daily-use consumer goods. Overall, in the last 3 years, and particularly since the 3d Plenum of the 11th Central Committee, here have been great changes in our country's science and technology scene, and the achievements of scientific research are becoming more numerous year after year. For example, the Chinese Academy of Sciences, the center of the country's scientific research, had a total of more than 1,300 research results in 1978, more than 1,400 in 1979, and 1,576 in 1980 (evaluations have indicated that 14 percent of them are close to or at the world state of the art). While the national defense scientific and technological system has been carrying out its sophisticated scientific and technical tasks with flying colors, it has also intensified its scientific research work for the populace. In 1980 the 7th Ministry of Machine Building alone made available 136 major new technologies, of which 43 are firsts for this country and 25 are at or close to the international state of the art. Innumerable vivid circumstances have given people an increasingly clear understanding of the immense role of science and technology in developing the national economy and promoting social progress, and have further stimulated our vast population's enthusiasm for studying and utilizing science and technology. Historical experience proves that whenever our party has laid increased emphasis on science and technology and scientific and technical personnel, our socialist cause has progressed more smoothly; and when it has not done so, the result has been setbacks of various degrees of seriousness. When the party Central Committee recently stressed again that the "entire party must lay emphasis on science" and pointed out that during the readjustment of the national economy we must also readjust the relationship between science and technology and economic development, gradually increasing the share of scientific research funds in the budget, and assuring that science makes steady progress, it summed up positive and negative historical experience and inferred that there is still a greater and lesser degree of failure within the party to accord due importance to science and technology. At present there are still many comrades within the party, including some who are in charge of economic and party and government leadership, who are insufficiently aware of the importance of science and technology and who do not sufficiently support scientific and technical work. Many party committees and administrative leadership organs have still failed to put scientific and technical work on their agendas, or pay lip service to its importance but actually relegate it to a secondary place, so that it loses out when the pressure of work increases. Some comrades even consider that science and technology stand in the same relationship to production and the economy as the cock-crow at the dawn, i.e that "dawn comes whether the cock crows or not," and that it makes no difference whether science and technology are pursued or not.

There are many reasons for this failure to accord due importance to science and technology. The small producer's narrow ideology and ingrained habit are an important social cause. Some comrades look at science and technology and at education with the small producer's eyes, and will not admit that they are extremely important for the cause of socialist construction and that socialist construction is impossible without them. To root out these influences, it is necessary to take worldwide view. In the capitalist countries, science and technology are not only a new means by which the capitalists squeeze out excess value, but also a basic factor in the development of modern large-scale production in capitalist society. At present in some developed capitalist countries rates of growth of the national economies exceeding 60 percent are based on scientific and technical progress, and many new production sectors have been entirely brought into being by science and technology. Science and technology are now advancing at a startling pace. In 10-odd years in the 1960's and 1970's, the number of new discoveries and new inventions in science and technology exceeded the total for the previous 2,000 years; every year basic engineering and technical knowledge and specialized knowledge increase by 5 and 20 percent respectively; in the past 10 years 30 percent of industrial knowledge has become outdated, and 50 percent of electronics technology has become outdated. Only if socialism creates a higher labor productivity than capitalism can it ultimately defeat capitalism. In this light, science and technology are a life-and-death matter for the two differing social systems of socialism and capitalism.

An important ideological source of the failure to accord due importance to science and technology is the many years' influence of "left" ideology. In theoretical terms, this influence is expressed as some comrades continued failure to recognize that science and technology are a productive force and that scientific research must precede production, and their failure to recognize that modern tools of production are embodied science and technology and that the person who constitutes the greatest productive force is the one armed with scientific and technical knowledge. In their thinking regarding the guidance of economic construction, some comrades cannot correctly handle the relationship between economic development and science and technology, and will not admit that science and technology have a critical role in economic construtfon. They do not accord importance to science and technology and do not rely upon them in economic construction; when they grasp production they fail to grasp science and technology; and when they embark on capital construction they do not make an effort at technological reform of existing enterprises; the result is that many of our country's scientific and technical achievements cannot be put into use and disseminated in timely fashion, many old enterprises' technologies, processes and equipment cannot be renovated and modernized, and they remain for a long time in a backward condition of high waste, low quality, and production of the same products year after year. Many years of this state of affairs in economic work have not only hindered the development of science and technology in our country but have harmed the country's socialist construction. In their policy on intellectuals, some comrades still discriminate against or even repress scientific and technical personnel and refuse to admit that the vast majority of the intellectuals, including 5 million scientific and technical personnel, belong to the working class, and are a force upon which the party relies. They have long suffered from a phobia about rightism and a belief that "better 'left' than right," and in the process of cadre reorganization they have rejected scientific and technical personnel with their specialized capabilities and organizational ability and have prevented them from participating in leadership groups at all levels, or have given them posts but failed to make use of them, so that they are little more than furniture.

To summarize, the habits of the small producer and the effect of "left" ideology have, to a greater or lesser degree, and in both visible and invisible ways, hindered the development of science and technology. As a result, if the entire party, starting with leadership comrades in party committees at all levels, is to truly make an effort to give due importance to science and technology, then it must take care to guard against and overcome the effects of the small-producer habit of mind and must conscientiously root out the "left" ideology. The aim of rooting out this ideology is to sum up experience and to raise consciousness in the implementation of the party's scientific and technical policy and its policy on intellectuals. The methods for rooting it out must be suitable, must be based on the actual situation in each department, locality and unit, must seek the truth from the actual situation, and must conscientiously solve the problems that exist.

In developing science and technology we must not stop with general slogans. We must also adopt correct policies, and organize all parties concerned for a joint effort to carry out a successful reorganization relative to science and technology. Recently the party Central Committee and the Council of Ministers approved the policy guidelines proposed by the party organization of the State Committee on Science and Technology regarding nationwide scientific and technological development in the immediate future. The main content of these guidelines is as follows: 1. Science and technology and the economy and society should develop in coordination with each other, and promotion of economic development should be made the primary task. 2. Stress should be laid on strengthening the study of production technologies, and technologies should be correctly selected and formed into a rational technological structure. 3. Technical development and dissemination of technology in factory and mining enterprises must be intensified. 4. Basic research must be maintained on a stable basis and gradually expanded. 5. Learning from and assimilating foreign science and technology should be treated as an important means of developing this country's science and technology. This is a relatively comprehensive set of guidelines which seek the truth in the actual situation, which were drawn up following preliminary rooting out of pernicious "left" influences, and which are beneficial to the entire readjustment of the national economy.

On the basis of these guidelines, the readjustment of scientific and technical work, and particularly the readjustment of its relationship to economic development, should take account of both the overall situation and of scientific research work itself.

In terms of the overall situation, the readjustment should have the effect of making economic work able to rely better on science and technology and to bring their role thoroughly into play. To this end, first, it is necessary to base major policy decisions in economic and social development on scientific research and thorough technical substantiation. Policy research and consultative organizations should be set up at the national level as quickly as possible. Second, an energetic effort should be made to implement uniform planning for scientific-technical, economic and social development. Third, a comprehensive review of our country's investment policy should be undertaken, and the share of funds for scientific research in the state budget gradually increased on this basis. Fourth, in order to improve economic effectiveness, rationalization and reorganization of the broad economic structure should be coordinated with technical renovation of older enterprises. If a reorganization of the economic structure is not undertaken, scientific and technical reform will result in a good deal of blind action; and if the reorganization of the economic structure is not combined with technical renovation, its results will have many limitations and will not be lasting. Fifth, we should actively and prudently reform the economic and scientific and technical management system, reasonably readjust the structure of science and technology and of the ranks of scientific and technical personnel, promote and organize from the top down the unification and coordination of the five front armies on the scientific and technical front, promote and organize unification and cooperation among scientific research, production and applications organizations and their attack on key technical problems, and conscientiously solve the problem of large amounts of unnecessary duplication in construction and research.

Scientific and technical work itself should make a greater and more effective contribution to promoting economic development. First, in a number of urgent near-term areas such as agriculture, light industry and textiles, energy, communications, machine building, materials, and electronics technology, it should select a few topics and solve certain scientific and technical problems which are of major importance for national economic and social development. The key is to select the right problems, in accordance with local conditions and the nature of the organizations, and to grasp correctly the principles of selecting research topics. At the same time, we should establish and fill out our country's own scientific and technical reserve for the long-term needs of economic and social development. Those who do not plan for the long term have difficulties in the short term. We cannot focus solely on immediate benefits. We must make allowances for long-term needs and energetically "take account of both the near term and the long term" and "coordinate near-term and long-term measures." The key in this endeavor is effective basic development of research. For an individual production department or a research system with a certain degree of integration, the basic development of research should include: a clear and stable direction of research and a properly regulated sequence of work; a politically firm party leadership group, an ideologically unprejudiced research collective, and effective administrative and management bodies; a reationally organized, high-quality, intellectually upright scientific and technical contingent; a precise and flexible information system (including information gathering, library materials and file work); and a good working and living environment which gradually creates the conditions for socialization of research support and technical services. It should also include: development of a practicable subject development policy and relevant technical-economic policy; and systematic, energetic education and training in rotation of scientific and technical management personnel, intensified development of legal institutions, regulations and systems for management of science and technology, and promotion of the specialization of research management and its development into a science.

Strengthening the party's leadership is the fundamental guarantee that our country's science and technology will advance unceasingly. The party Central Committee has great concern for and accords full importance to scientific and technical work. The Central Committee Secretariat regularly requests scientists to make reports, and recently it has heard many reports by the party organizations of the State Committee on Science and Technology and the Chinese Academy of Sciences as well as reports on scientific and technical cadre work from the CCP Central Organization Department, and the State Council's Office of Scientific and Technical Cadres and Office of Personnel Matters, and has issued many important directives and set a model for party and government leadership comrades at all levels. Strengthening the leadership of science and technology is the glorious task which the age has assigned to our party. If the entire party accords due importance to science and technology and painstakingly acquires scientific and technical knowledge and masters the management of science, the party's leadership of science will be strengthened.

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PHYSICAL SCIENCES

METHOD TO IMPROVE SATELLITE ORBIT BY SPARSE OBSERVATION OUTLINED

Beijing TIANWEN XUEBAO [ACTA ASTRONOMICA SINICA] in Chinese Vol 21, No 2, Jun 80 pp 93-95

[Article by Xu Pinxin [1776 0756 2450] of the Purple Mountain Astronomical Observatory of the Chinese Academy of Sciences: "A Method of Improving the Orbit of an Artificial Satellite by Sparse Observations"*]

[Text] The commonly used method of improving the orbit of an artificial satellite requires that the segment of the orbit observed is not too short and the period of time over which the observational data are distributed is not too long.[1] These two requirements are mutually conflicting. For a long time we have depended upon our own nation's observations and mainly upon optical observations for forecasting the orbit of artificial satellites, and frequently, concentrated observation of a lengthy segment of the orbit within a short time is not possible (the ascending segment and the descending segment of the passing). This has forced us to utilize sparse observations distributed over a relatively long period of time for orbital improvement. For this, a way must be found to overcome the difficulty that "the period of time in which the data are distributed must not be too long" as described above.

A brief analysis of the commonly used method of orbital improvement shows that the time period cannot be too long because the variable part of the mean anomaly M contains unknowns which have to be improved with other number of orbits together. To facilitate derivation of the differential equations of correlation, the polynomial of indeterminate coefficients is generally used to express the variable part of M. Because the changes of such factors as atmospheric density with time are very complex, the resulting variations of M can only be expressed better by the polynomial if they occur within a short period of time. Over a long time, the user of a parametric model that is much more complex than the polynomial to express variations of M will increase the complexity of the derived differential relation or greatly increase the number of unknowns. To do away with the parametric model and use other numerical methods to express the varitions of M better are even more difficult. Facing this situation, we have proposed the method of treating M separately from the other numbers of orbits.

We have divided the six number of orbits into three groups: the angle of inclination i of the orbit and the ascending node of intersection with the equatorial

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*This article was received on 28 December 1979

longitude Ω are the first group, the eccentricity e and the amplitude angle ω at the point close to earth are the second group, M and a the semi-major radius a are the third group. These three groups of numbers of orbits are improved separately. When improving one group, the approximate values of the other two groups of orbits are used. During the course of each improvement, the results of the previous improvement are used as these approximate values.

The actual method of calculation is as follows:

First in radar observation, we assume there are N pieces of observational data distributed within a relatively long time. The time of observations are t_1, t_2, $\cdots$, t_n. We start out from the approximate values of the orbits at time t_0, and using the values of a of the N number of times obtained from the previous improvement as the constraints for computing the perturbations, the theoretical values of i, Ω, e and ω at these N number of times can be computed according to perturbation theory.

Let the geocentric distance, geocentric equatorial longitude and geocentric equatorial latitude at these N number of times of observations of a satellite measured by radar be r_j, ℓ_j, φ_j, $j = 1, 2, \cdots, N$, then from the relation

$$\frac{\sin u}{\cos u} = \frac{\sin i \sin \varphi + \cos i \cos \varphi \sin (\ell - \Omega)}{\cos \varphi \cos (\ell - \Omega)},$$

$$\theta \approx \sin \theta = \cos i \sin \varphi - \sin i \cos \varphi \sin (\ell - \Omega).$$

we obtain u_j and θ_j, $j = 1, 2, \cdots, N$. (For clarity, in the above equations and in some of the following equations, the subscript j is omitted). Here, u_j and θ_j are respectively the longitude and the latitude when the plane of the orbit is used as the reference plane.

Using the least square method to solve the N number of bivariate equations:

$$\left(\sin u - \sin i \cos u \frac{\partial}{\partial i} \int_{t_0}^{t} \dot{\Omega} dt\right) \Delta i - \sin i \cos u \Delta\Omega = \theta$$

we can obtain Δi and $\Delta\Omega$.

Using the least square method again to solve the second group of the N numbers of bivariate equations:

$$\left[\cos (u - \omega) + \frac{2ae}{r}\right] \Delta e + e \sin (u - \omega) \Delta\omega = \frac{a(1 - e^2)}{r} - [1 + e \cos (u - \omega)].$$

we can obtain Δe and $\Delta\omega$.

The Δi, $\Delta\Omega$, Δe, $\Delta\omega$, are the corrections of the approximate values of i, Ω, e, ω at time t_0.

Then we solve for M and a of the third group of numbers of radicals:

For each t_i, and from

$$\frac{\sin E}{\cos E} = \frac{(1 - e^2)^{\frac{1}{2}} \sin (u - \omega)}{\cos (u - \omega) + e}$$

we can obtain E_j, and further obtain $M_j = E_j - e_j \sin E_j$, $j = 1, 2, \cdots, N$.

For a time series like M, we can freely select various methods of treatment. We can use the parametric model that is much more complex than the polynomial for approximation, and we can also do away with the parametric model and use other numerical methods, for example, other statistical methods of sectional polynomial approximation (the sections vary with approximations) and time series analysis. From the differential quotient of M over time we can obtain the mean motion n and the semi-major radius a at the N number of times.

Starting out from the number of orbits at time t_0 thus improved, and utilizing the N number of values a recalculated in this way as the constraints, we can recalculate the theoretical values of i, Ω, e, and ω at the N number of times and perform the above improvement performed until the absolute values of Δi, ΔΩ, Δe, and Δω are sufficiently small.

For optically observed data, we only have to convert the measured angular data to spatial coordinates and the above computations for radar data can be suitably applied. The modern optical instruments used to observe artificial satellites allow the recording of a series of observational points during one passing of the satellite and in most cases there are at least two points. Therefore, we can pair the data obtained from one passing of the satellite and utilize the mechanical relations of osculating elliptic motion and the approximated values of some of the numbers of orbits previously improved to convert the optically measured angular data into approximate spatial coordinates. As the number of orbits are gradually improved, these spatial coordinates are also gradually improved. The actual method of computation is as follows:

Let the number of optical data obtained from one passing of the satellite be p ($p > 1$). Arrange them in a time sequence and pair the number k piece of data ($K = 1, 2, \cdots \left[\frac{p+1}{2}\right]$, [ ] represents the integer part) and the number $K + \left[\frac{p}{2}\right]$ piece of data. The subscripts 1 and 2 designate the various paired and related pieces of data. The approximate values r_1', r_2' of the geocentric distances of the satellite at the times t_1, t_2 of observation can be obtained from the improved approximate numbers of orbits of last time. Because $t_2 - t_1$ is far smaller than the orbital period of the satellite, we can consider the difference between r_1', r_2' and their true values r_1 and r_2 to be $r_1 - r_1' \approx r_2 - r_2' \approx \Delta r$. Thus, let

$$r_m = r_m' + \Delta r, \quad m = 1, 2 \text{ (same as follows)}$$

and since the unit vector $\mathbf{D}_m^0$ of the direction of observation and the vector $\mathbf{R}_m$ of the geocentric position of the observation station at the time of $\mathbf{R}_m$ observation are known, the vector of the geocentric position of the satellite can be represented as

$$r_m = R_m + D_m D_m^0,$$

where

$$D_m = \sqrt{r_m^2 + (D_m^0 \cdot R_m)^2 - |R_m|^2} - D_m^0 \quad R_m.$$

Then we substitute r_m into the equation of Lambert's law of osculating elliptic motion to derive the equation satisfied by Δr. For this, let

$$\sin = |r_2 - r_1|, \quad \sin \frac{\varepsilon}{2} = \frac{1}{2} \sqrt{\frac{r2 + r1 + s}{a}},$$

$$\cos = \frac{\delta}{2} = \frac{1}{2} \sqrt{\frac{r2 + r1 - s}{a}}.$$

then $(\varepsilon - \sin \varepsilon) - (\delta - \sin \delta) = n\,(t_2 - t_1)$ is a transcendental equation of Δr. The a and n are the osculating number of orbits at time $\frac{1}{2}(t_2 + t_1)$ calculated from the first improvement. We can obtain Δr using proportional interpolation to solve this equation and contain r_m. Thus, optically measured angular data are gradually converted to approximate spatial coordinates.

When only one piece of data has been obtained during one passing of the satellite, four of the six orbits which were improved upon last time can be used to convert this single piece of data into spatial coordinates. As the orbits are gradually improved, these spatial coordinates are also gradually improved. When such spatial coordinates are included in the computations, they will still contribute to the improvement of the remaining two of the six orbits.

There have been very few theoretical studies on the convergence of the gradual iteration process of improving the orbits of artificial satellites. The iteration process of our method is more complicated than the commonly used method of improving orbits. At present, we can only examine its convergence by actual computation. Begining from 1976, we have been using this method to improve orbits on a trial basis in predicting orbits of artificial satellites. Practice of more than 3 years shows that the convergence properties of this method are equivalent to those of the commonly used method of orbital improvement for concentrated observations and better than those of the commonly used method of orbital improvements for sparse observations.

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9296
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PHYSICAL SCIENCES

SECOND ORDER SOLUTION OF SATELLITE ORBITAL PERTURBATION IMPROVED

Beijing TIANWEN XUEBAO [ACTA ASTRONOMICA SINICA] in Chinese Vol 21 No 3, Sep 80 pp 278-286

[Article by Liu Lin [0491 2651] and Zhao Dezi [6392 1795 3320] of the Astronomy Department of Nanjing University: "Improvement of the Second Order Solution of Orbital Perturbation of the Artificial Earth Satellite"*]

[Text] Abstract

Derivation and the result of the second order analytic solution of orbital perturbation of the artificial earth satellite are both very complicated. This article gives three improved methods under the prerequisite of retaining the advantages of the analytic solution. Among them, the method based on a combination of the elliptic perturbation theory and the intermediate orbit theory has obvious advantages. The derivation procedures and the results are all very simple. They can be used to obtain second order solutions and they can also be conveniently used to obtain a first order solution or high order solutions.

I. Introduction

From the practical point of view, the analytic solution has two shortcomings:

(1) The formula for the long periodic term is very long and complicated. This is because when the regular transform method (or mean number of orbits method) is used, these terms must be strictly separated.

(2) The second order short periodic term $\delta_s^2(J_2^2)$ brought about by the J_2 term is also very complicated.

Facing these two shortcomings, we have proposed three improved methods:

Method I: Mixed use of regular transform and classical iteration. First we use the method of regular transform to separate the short periodic terms, i.e., $\delta(t) = \delta'(t) + \delta_s(t)$,[1] and simplify $\delta_s(t)$. Then the transformed Hamilton function gives us the equation for solving $\delta'(t)$. Because the righthand function no longer contains the fast variable $\tilde{l}$, therefore it can be solved by classical iteration, thus overcoming the first shortcoming of the analytic solution.

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* This article was received on 22 Decemb[illegible]79.

1) The sign and the definition of the variables are the same as in reference (1).

Method II: The use of the intermediate orbit in the elliptic perturbation theory. On the basis of method I, the advantages of the intermediate orbit are fully utilized to overcome the complexity of derivation and expression of the formulas of the J_2, J_3 terms of perturbation, and thus overcoming the two major shortcomings of pure analysis.

Method III: The method of discussion and the major results of the elliptic perturbation theory are used in the intermediate orbital perturbation theory. The intermediate orbital solutions yield integral constants and constant transform can be used to establish the remaining equations of perturbation. Similar to method I, regular transformation is used to separate the short periodic terms, and then the classical iteration method is used to solve the long temporal terms and the long periodic terms. If the required precision of the second order solution is taken into consideration, the solution of the intermediate orbit can be simplified, thus fully utilizing the corresponding results of the original elliptic perturbation theory. This reduces the complexity of calculating the perturbation on the basis of the intermediate orbit.

II. Method I.

This method still uses the variables σ without a singularity ($e=0$): $\tilde{L}$, $\tilde{G}$, $\tilde{H}$, $\tilde{l}$, $\tilde{g}$, $\tilde{h}$, and after the regular transform yields the short periodic term $\sigma_s(t)$, the instantaneous number of roots $\sigma(t)$ can be expressed as:

$$\sigma(t) = \sigma'(t) + \sigma_s(t) \tag{1}$$

where the form of $\sigma_s(t)$ is:

$$\sigma_s(t) = \sigma_s^{(1)}(\sigma', t) + \sigma_s^{(2)}(\sigma', t) + \cdots, \tag{2}$$

while $\sigma'(t)$ is solved by the following equations:

$$d\sigma'/dt = F_0 + F_1 + F_2 + F_3, \tag{3}$$

The subscripts designate the order, derived from the partial differentiation of the variables corresponding to the Hamilton functions $\tilde{F}_0^*$, $\tilde{F}_1^*$ $\cdots$ given by the regular transform separating the short period terms. To differentiate the right hand functions of each variable, $(F_1)_\sigma$, $(F_2)_\sigma$, $(F_3)_\sigma$, can be used.

Because the right hand function of equation (3) does not contain fast variables, therefore it can be solved using classical iteration. For example, for the perturbation of the earth's shape, we have:

$$dL'/dt = 0,\ dH'/dt = 0,$$

$$\frac{dG'}{dt} = (F_1)_G(L'_0, G'_0, H'_0, g'_0) + \frac{\partial(F_2)_G}{\partial g'}(F_1)_g(t - t_0) + (F_2)_G(L'_0, G'_0, H'_0, g'_0),$$

$$\frac{dl'}{dt} = F_0(L'_0) + (F_1)_l(L'_0, G'_0, H'_0) + \frac{\partial(F_1)_l}{\partial G'}(F_2)_G(t - t_0) + (F_2)_l(L'_0, G'_0, H'_0, g'_0)$$
$$+ \frac{\partial(F_2)_l}{\partial g'}(F_1)_g(t - t_0) + (F_2)_l(L'_0, G'_0, H'_0, g'_0),$$

$$\frac{dg'}{dt} = (F_1)_g(L'_0, G'_0, H'_0) + \frac{\partial(F_1)_g}{\partial G'}(F_2)_G(t - t_0) + (F_2)_g(L'_0, G'_0, H'_0, g'_0)$$
$$+ \frac{\partial(F_2)_g}{\partial g'}(F_1)_g(t - t_0) + (F_2)_g(L'_0, G'_0, H'_0, g'_0),$$

$$\frac{dh'}{dt} = (F_1)_h(L'_0, G'_0, H'_0) + \frac{\partial(F_1)_h}{\partial G'}(F_2)_G(t - t_0) + (F_2)_h(L'_0, G'_0, H'_0, g'_0)$$
$$+ \frac{\partial(F_2)_h}{\partial g'}(F_1)_g(t - t_0) + (F_2)_h(L'_0, G'_0, H'_0, g'_0). \qquad (4)$$

For clarity of expression, we used the equation expressed in the original Delaunay variables. By the method of References (1) or (2), the equation can be reduced to an equation of the variables $\tilde{L}'$, $\tilde{G}'$, $\tilde{H}'$, $\tilde{l}'$, $\tilde{g}'$, $\tilde{h}'$ without singularities. They are written in the following standardized and abbreviated form:

$$d\sigma'/dt = f_1(\tilde{L}'_0, \tilde{G}'_0, \tilde{H}'_0, \tilde{g}'_0) + f_2(\tilde{L}'_0, \tilde{G}'_0, \tilde{H}'_0, \tilde{g}'_0)(t - t_0). \qquad (5)$$

The largest term on the right side of equation (5) lost was $J_2^4 \cdot (N \cdot 2\pi)^2/2$, N is the number of revolutions around earth. Therefore, according to the required precision of 18^{-8} in positioning the satellite, the perturbation of 1 to 3 days can be computed by using 2 to 3 revolutions as one step in the calculation. The "cutoff error" of each step is $J_2^4 \cdot (N \cdot 2\pi)^3/6$. Thus, the computational formula for $\sigma'(t)$ can be obtained by integrating equation (5):

$$\sigma'(t) = \sigma'(t_0) + \sum_k (f_1)_k \Delta t_k + \sum_k (f_2)_k \frac{\Delta t_k^2}{2}, \qquad (6)$$

$$\Delta t_k = t_{k+1} - t_k \quad (k = 0, 1, \cdots). \qquad (7)$$

This is a kind of multiple step instantaneous number of orbits method to change the zero point, similar to a kind of simplest numerical integration--Euler-Maclaurin (formula) method.

Summarizing the above, the heart of this method is to obtain the right hand functions f_1, f_2 of $\sigma_s(t)$ and equation (6). The equation $\sigma_s(t)$ has already been discussed in reference (1). After we simplified it, the computation was easier. For f_1 and f_2, the Hamilton function $\tilde{F}^*$ given in reference (1) and equation (4) given in this article are not difficult to obtain. For other perturbations, similar methods can be used to obtain the solution.

This method retains the main advantages of the analytic method. The right hand function f_1 and f_2 need not be treated otherwise, and the "steps" of integration are larger, therefore the computational procedure is simple, the time of computation is shorter, and at the same time, such problems as the critical angle are avoided, and application is convenient.

III. Intermediate Orbital Solution

On the basis of the above method, we use the intermediate orbit to overcome the second shortcoming of the analytic method. For this, we must provide an intermediate orbital solution of a definite precision.

We use the Aksenov type positional function[3,4] i.e.,

$$\begin{aligned} V_0 &= [(1+id)r_1^{-1} + (1-id)r_2^{-1}]/2, \\ r_1 &= \{x^2 + y^2 + [z - c(d+i)]^2\}^{\frac{1}{2}}, \\ r_2 &= \{x^2 + y^2 + [z - c(d-i)]^2\}^{\frac{1}{2}}, \end{aligned} \tag{8}$$

where $i = \sqrt{-1}$ is the imaginary unit. It includes the geocentric gravity and the perturbations of all J_2 terms and J_3 terms and most J_4 terms.

Using the spatial Thiele transformed ellipsoidal coordinates:

$$\begin{aligned} x + iy &= r\cos\varphi e^{i\lambda} = [(\rho^2 + c^2)(1-\mu^2)]^{\frac{1}{2}} e^{i\lambda}, \\ z &= r\sin\varphi = \rho\mu + cd, \end{aligned} \tag{9}$$

the positional function (8) can be reduced to:

$$V_0 = (\rho - cd\mu)/(\rho^2 + c^2\mu^2). \tag{10}$$

c, d, are two constants determined by J_2 and J_3. The relations are:

$$c = [J_2 - (J_3/2J_2)^2]^{\frac{1}{2}}, \quad cd = (J_3/2J_2). \tag{11}$$

Specifically for this positional function we use the Vinti method[5] for expansion to obtain the corresponding intermediate orbital solution. Due to the requirements of the second order solution, we have deleted the derivation process and have given the results as follows:

$$\begin{aligned} \frac{1}{2}\left[\frac{\rho^2 + c^2\mu^2}{\rho^2 + c^2}\dot{\rho}^2 + \frac{\rho^2 + c^2\mu^2}{1-\mu^2}\dot{\mu}^2 + (\rho^2 + c^2)(1-\mu^2)\dot{\lambda}^2\right] - \frac{\rho - cd\mu}{\rho^2 + c^2\mu^2} &= \alpha_1, \\ 2\alpha_1\rho^2 + 2\rho + \frac{c^2\alpha_3^2}{\rho^2 + c^2} - \frac{(\rho^2 + c^2\mu^2)^2}{\rho^2 + c^2}\dot{\rho}^2 &= \alpha_2, \\ (\rho^2 + c^2)(1-\mu^2)\dot{\lambda} &= \alpha_3. \end{aligned} \tag{12}$$

$$
\begin{aligned}
t + \beta_1 = {} & (-2\alpha_1)^{-\frac{1}{2}}\left[\left(a - \frac{A}{2}\right)E - ae\sin E + p\sqrt{1-e^2}\left(A_0 f + \sum_{j=1}^{3} A_{1j}e^j \sin jf\right)\right] \\
& + (\alpha_2^2 - \alpha_3^2)^{-\frac{1}{2}} Q_0^{-\frac{1}{2}} \mu_1^2 \left[A_1\phi + \sum_{j=1}^{2}\left(B_{1,2j-1}\cos(2j-1)\phi + B_{1,2j}\sin(2j)\phi\right)\right], \\
\beta_2 = {} & -\alpha_2(-2\alpha_1)^{-\frac{1}{2}}\frac{\sqrt{1-e^2}}{p}\left[A_0 f + \sum_{j=1}^{3} A_{2j}e^j \sin jf\right] \\
& + \alpha_2(\alpha_2^2 - \alpha_3^2)^{-\frac{1}{2}} Q_0^{-1/2} \mu_1 \left[B_0\phi + \sum_{j=1}^{2}\left(B_{2,2j-1}\cos(2j-1)\phi + B_{2,2j}\sin(2j)\phi\right)\right], \\
\beta_3 - \lambda = {} & \alpha_3(-2\alpha_1)^{-\frac{1}{2}}\frac{\sqrt{1-e^2}}{p}\gamma_1^2\left[A_0 f + \sum_{j=1}^{4} A_{3j}e^j \sin jf\right]
\end{aligned}
\tag{13}
$$

The α_1, α_2, α_3, β_1, β_2, β_3 in the above equations are six integral constants while β_1, β_2, β_3 also contain any part related to α_1, α_2, α_3. They should be separated but for method II that will be discussed later, there is no need to separate them. As for method III, how are they to be separated? This will be discussed elsewhere. The relationship between E and f in equation (13) is the same as the binary problem. The related auxiliary quantities are as follows:

$$
k_0 = c^2/\alpha_2^2,\quad x^2 = -2\alpha_1\alpha_2^2,\quad y^2 = \cos^2 i_0 = \alpha_3^2/\alpha_2^2; \tag{14}
$$

$$
\left\{
\begin{aligned}
& B = \frac{1}{\langle\rho_1\rho_2\rangle}\frac{\alpha_2^2}{(-2\alpha_1)}\sin^2 i_0 c^2, \\
& A = \frac{1}{\langle\rho_1\rho_2\rangle - B}\frac{B - c^2}{(-\alpha_1)}, \\
& \rho_1\rho_2 = \frac{\alpha_2^2}{(-2\alpha_1)} + A\left(\frac{1}{(-\alpha_1)} + A\right) - (B - c^2),
\end{aligned}
\right.
\tag{15}
$$

$$
\begin{aligned}
\langle\rho_1\rho_2\rangle = {} & \alpha_2^2\cdot(-2\alpha_1)^{-1}\{1 + k_0y^2(x^2 - 4) + k_0^2y^2[16(1 - 2y^2) - 4x^2(3 - 5y^2) \\
& + x^4(1 - y^2)]\},
\end{aligned}
$$

$$
\left\{
\begin{aligned}
& \mu_1^2 = \langle\mu_2\rangle^{-1}\cdot(-2\alpha_1)^{-1}\cdot\alpha_2^2\cdot\sin^2 i_0,\quad \mu_2^{-2} = c^2/\langle\mu_2\rangle, \\
& K_0 = d\cdot c^{-1}\alpha_2^{-1}\cdot(1 - \mu_2^{-2})(1 - \mu_1^2\mu_2^{-2})^{-1},\quad D_0 = d\cdot c^{-1}\alpha_2^{-1} - K_0,
\end{aligned}
\right.
\tag{16}
$$

$$
\langle\mu_2\rangle = \frac{\alpha_2^2}{(-2\alpha_1)}\left\{1 + k_0x^2y^2 + k_0^2x^4y^2\left[(1 - y^2) + \frac{1}{\alpha_2^2}\left(\frac{d}{c}\right)^2\right]\right\}.
$$

$$
a = 1/(-2\alpha_1) + A/2,\quad e^2 = 1 - (\rho_1\rho_2/a^2),\quad p = a(1 - e^2) = \rho_1\rho_2/a, \tag{17}
$$

$$
\left.
\begin{aligned}
& k_1 = B/p^2,\quad p_0 = -Ap/2B, \\
& \rho_1^2 = \frac{c^2}{B},\quad \rho_2^2 = 1 + 2\rho_1^2,\quad \rho_3^2 = 1 + \frac{2}{3}\rho_1^2,\quad \rho_4^2 = 1 + \frac{4}{3}\rho_1^2 + \frac{8}{3}\rho_1^4, \\
& K_1 = 1 + \frac{e^2}{2},\quad K_2 = 1 + \frac{3}{2}e^2,\quad K_3 = 1 + 3e^2 + \frac{3}{8}e^4, \\
& K_4 = 1 + 5e^2 + \frac{15}{8}e^4,\quad K_5 = 1 + \frac{15}{2}e^2 + \frac{45}{8}e^4 + \frac{5}{16}e^6, \\
& K_6 = 1 + \frac{e^2}{4},\quad K_7 = 1 + \frac{3}{4}e^2,\quad K_8 = 1 + \frac{e^2}{6}.
\end{aligned}
\right\}
\tag{18}
$$

$$A_1 = k_1\left(-\frac{1}{2}\right) + k_1^2\left(\frac{3}{2}\rho_0^2 - \frac{3}{2}\rho_0 + \frac{3}{8}K_1\right)$$

$$+ k_1^3\left(\frac{5}{2}\rho_0^3 - \frac{15}{4}\rho_0^2 K_1 + \frac{15}{8}\rho_0 K_2 - \frac{5}{16}K_3\right),$$

$$A_{11} = k_1^2\left(\frac{3}{4} - \frac{3}{2}\rho_0\right), \quad A_{12} = k_1^3\left(\frac{3}{32}\right). \tag{19}$$

$$A_2 = 1 + k_1\left(\rho_0 - \frac{1}{2}K_1\right) + k_1^2\left(\frac{3}{2}\rho_0^2 K_1 - \frac{3}{2}\rho_0 K_2 + \frac{3}{8}K_3\right)$$

$$+ k_1^3\left(\frac{5}{2}\rho_0^3 K_2 - \frac{15}{4}\rho_0^2 K_3 + \frac{15}{8}\rho_0 K_4 - \frac{5}{16}K_5\right).$$

$$\left.\begin{aligned} A_{21} &= k_1(\rho_0 - 1) + k_1^2\left(3\rho_0^2 - \frac{9}{2}\rho_0 K_1 + \frac{3}{2}K_2\right), \\ A_{22} &= k_1\left(-\frac{1}{8}\right) + k_1^2\left(\frac{3}{8}\rho_0^2 - \frac{9}{8}\rho_0 + \frac{9}{16}K_1\right), \\ A_{23} &= k_1^2\left(-\frac{1}{8}\rho_0 + \frac{1}{8}\right), \quad A_{24} = k_1^3\left(\frac{3}{256}\right). \end{aligned}\right\} \tag{20}$$

$$A_3 = k_1 K_1 + k_1^2\left(\rho_0 K_2 - \frac{1}{2}\rho_0^2 K_3\right) + k_1^3\left(\frac{3}{2}\rho_0^2 K_3 - \frac{3}{2}\rho_0\rho_0^2 K_4 + \frac{3}{8}\rho_0^2 K_5\right),$$

$$\left.\begin{aligned} A_{31} &= 2k_1 + k_1^2(3\rho_0 K_2 - 2\rho_0^2 K_3), \\ A_{32} &= \frac{1}{4}k_1 + k_1^2\left(\frac{3}{4}\rho_0 - \frac{3}{4}\rho_0^2 K_1\right), \\ A_{33} &= k_1^2\left(\frac{1}{12}\rho_0 - \frac{1}{6}\rho_0^2\right), \quad A_{34} = k_1^3\left(-\frac{1}{64}\rho_0^2\right). \end{aligned}\right\} \tag{21}$$

$$Q_0 = 1 + \frac{1}{2}K_0 D_0 \mu_1^{-2} - \frac{1}{4}D_0^2 \mu_1^{-2}, \quad k_1 = \frac{1}{Q_0}\mu_1\mu_1^{-2}(K_0 - D_0)\left(1 + \frac{D_0^2}{8\mu_1^2}\right). \tag{22}$$

$$\left.\begin{aligned} & Q_1 = \frac{-\mu_1}{K_0 - D_0}\left(1 + \frac{D_0^2}{8\mu_1^2}\right), \quad Q_2 = \frac{D_0}{\mu_1 k_1}, \quad Q_3 = \mu_1\left(\frac{D_0}{k_1}\right)\left(1 + \frac{D_0^2}{8\mu_1^2} + \frac{D_0^2}{4}\right), \\ & Q_4 = \mu_1^2\left(1 + \frac{D_0^2}{4\mu_1^2} + \frac{D_0^2}{4}\right), \quad Q_5 = -2k_0^2\epsilon_0^2\left(\frac{d}{c}\right)^2 y^2(1 - y^2), \\ & Q_6 = -2k_0\epsilon_0^2\left(\frac{d}{c}\right)y^2(1 - y^2)^{\frac{1}{2}}\left[1 + \frac{1}{2}k_0\epsilon^2(4 - 7y^2)\right], \\ & Q_7 = 2k_0\epsilon_0^2\left(\frac{d}{c}\right)(1 - y^2)^{\frac{1}{2}}\left[1 + \frac{3}{2}k_0\epsilon^2(1 - 2y^2)\right], \\ & Q_8 = 1 + \frac{1}{2}k_0\epsilon^2(1 - y^2) + \frac{1}{8}k_0^2\left[\epsilon^4(3 - 10y^2 + 7y^4) + 4\epsilon_0^2\left(\frac{d}{c}\right)^2\epsilon^2(3 - 6y^2 + 2y^4)\right] \end{aligned}\right\} \tag{23}$$

$$B_1 = c^2\left\{\frac{1}{2} + k_2\left(-\frac{3}{16}Q_1\right) + k_2^2\left[\frac{9}{64}\left(1 + \frac{5}{6}Q_1^2\right) - \frac{1}{4}Q_1\left(1 - \frac{3}{2}Q_1\right)\right]\right\}.$$

$$\left.\begin{aligned} &B_{11} = c^2k_2\left(\frac{3}{8} - Q_1\right), \quad B_{12} = c^2k_2\left(-\frac{1}{24}\right), \\ &B_{13} = c^2\left[\left(-\frac{1}{4}\right) + k_2\left(\frac{1}{8}Q_1\right)\right], \quad B_{14} = c^2k_2\left(-\frac{1}{64}Q_1\right). \end{aligned}\right\} \tag{24}$$

$$B_2 = 1 + k_2\left(-\frac{1}{4}Q_1\right) + k_2^2\left(\frac{3}{16}\right)\left(1 + \frac{3}{4}Q_1^2\right) + k_2^2\left(-\frac{45}{128}Q_1\right)\left(1 + \frac{5}{18}Q_1^2\right).$$

$$\left.\begin{aligned} &B_{21} = k_2\left(\frac{1}{2}\right) + k_2^2\left(-\frac{9}{16}Q_1\right), \quad B_{22} = k_2^2\left(\frac{1}{16}Q_1\right), \\ &B_{23} = k_2\left(\frac{1}{8}Q_1\right) + k_2^2\left(-\frac{3}{32}\right)(1 + Q_1^2), \quad B_{24} = k_2^2\left(\frac{3}{256}Q_1^2\right). \end{aligned}\right\} \tag{25}$$

$$\left.\begin{aligned} &B_3 = \frac{1}{2}k_2\left(\frac{Q_1}{Q_4}\right) - \frac{3}{8}k_2^2\left(\frac{1}{Q_4}\right)\left(1 + \frac{1}{2}Q_1^2 + \frac{Q_1^2}{Q_4}\right) + \frac{15}{32}k_2^2\left(\frac{Q_1}{Q_4}\right)\left[\left(1 + \frac{1}{4}Q_1^2\right.\right. \\ &\qquad \left.\left. + \frac{1}{3}\frac{Q_1^2}{Q_4}\right) + \frac{2}{Q_4}\left(1 + \frac{1}{3}\frac{Q_1^2}{Q_4} + \frac{4}{5}Q_4\right)\right]. \\ &B_{31} = \frac{3}{4}k_2^2\left(\frac{Q_1}{Q_4}\right), \quad B_{32} = \frac{3}{32}k_2^2\left(\frac{Q_1^2}{Q_4}\right). \\ &B_4 = 1 + \frac{1}{2}k_2\sigma^2y^2\left\{1 + k_2\sigma^2\left[\left(1 - \frac{5}{4}y^2\right) + \frac{1}{2a_1^2}\left(\frac{d}{c}\right)^2(3 - y^2)\right]\right. \\ &\qquad \left. + k_2^2\sigma^4\left[\left(1 - \frac{7}{2}y^2 + \frac{21}{8}y^4\right) + \frac{1}{4a_1^2}\left(\frac{d}{c}\right)^2(11 - 40y^2 + 11y^4)\right]\right\}. \end{aligned}\right\} \tag{26}$$

$$e\cos E = 1 - \frac{\rho}{a}, \quad \operatorname{tg}\frac{f}{2} = \sqrt{\frac{1+e}{1-e}}\operatorname{tg}\frac{E}{2}, \quad \sin\phi = \frac{1}{\mu_1}\left(\mu - \frac{D_3}{2}\right)\left(1 - \frac{D_3^2}{8\mu_1^2}\right). \tag{27}$$

$$x = 2k\pi + \operatorname{tg}^{-1}\left[\frac{y\left(2Q_6\operatorname{tg}\frac{\Delta\phi}{2} + Q_7\right)}{\left(1 - \operatorname{tg}^2\frac{\Delta\phi}{2}\right) + Q_6\operatorname{tg}\frac{\Delta\phi}{2} + Q_7}\right],$$

$$\Delta\phi = \phi - 2k\pi, \quad 0 \leqslant \Delta\phi < 2\pi, \quad k = 0, \pm 1, \pm 2, \cdots. \tag{28}$$

For the polar orbit ($i_0 = \pi/2$), $y = 0$. Except at the two "poles" of the satellite where ($\Delta\psi = \pm\pi/2$), the computation of x will not have any problems, but the longitude λ corresponding to the two "poles" is not fixed. In fact, this does not affect computing the position of the satellite. At λ this time, the corresponding $\mu = 1$. Any value can be taken, and furthermore, the probability of encountering the above situation in computation is zero and there is no need for consideration.

By integration, the first two equations in equations (13) can be solved for E, f, ψ by iteration similar to the iteration used to solve the Kepler equations. Thus the formulas for computing (ρ, μ, λ) and ($\dot{\rho}$, $\dot{\mu}$, $\dot{\lambda}$) are:

$$\left.\begin{aligned} &\rho = a(1 - e\cos E), \quad \mu = \mu_1\left(1 + \frac{D_1^2}{8\mu_1^2}\right)\sin\phi + \frac{D_1}{2}, \\ &\lambda = \beta_3 - \alpha_3(-2\alpha_1)^{-\frac{1}{2}}\frac{\sqrt{1-e^2}}{p_\infty}\rho\left[A_1 f + \sum_{j=1}^{4} A_{1j}e^j \sin jf\right] \\ &\quad + \alpha_3(\alpha_2^2 - \alpha_3^2)^{-\frac{1}{2}}Q_0^{-\frac{1}{2}}\left(1 - \frac{D_1^2}{4}\right)^{-1}\mu_1\left[\frac{\alpha_2}{\alpha_3}(B_1\phi + B_{11}\cos\phi + B_{12}\sin 2\phi)\right. \\ &\qquad \left. + B_4 X\right]; \end{aligned}\right\} \tag{29}$$

$$\dot{\rho} = (ae\sin E)\dot{E}, \quad \dot{\mu} = \left[\mu_1\left(1 + \frac{D_1^2}{8\mu_1^2}\right)\cos\phi\right]\dot{\phi}, \quad \dot{\lambda} = \alpha_3/(\rho^2 + c^2)(1 - \mu^2);$$

$$\begin{aligned} \dot{E} = (-2\alpha_1)^{\frac{1}{2}}\Bigg\{&\frac{1}{(-2\alpha_1)}[1 - (-2\alpha_1)ae\cos E] + \left[p\sqrt{1-e^2}\left(A_1 + \sum_{j=1}^{4} jA_{1j}e^j\cos jf\right)\right. \\ &\left. + \mu_1^{\frac{1}{2}}\Phi\left(B_1 + \sum_{j=1}^{3}\left(-(2j-1)B_{1,2j-1}\sin(2j-1)\phi + 2jB_{1,2j}\cos(2j)\phi\right)\right)\right] \\ &\times (1-e^2)^{-\frac{1}{2}}(1 + e\cos f)\Bigg\}^{-1}, \end{aligned} \tag{30}$$

$$\dot{\phi} = (-2\alpha_1)^{-\frac{1}{2}}(\alpha_2^2 - \alpha_3^2)^{\frac{1}{2}}Q_0^{\frac{1}{2}}\mu_1^{-1}\Phi(1-e^2)^{-\frac{1}{2}}(1 + e\cos f),$$

$$\Phi = \frac{(1-e^2)^{\frac{1}{2}}p^{-1}\left(A_1 + \sum_{j=1}^{4} jA_{1j}e^j\cos jf\right)}{B_1 + \sum_{j=1}^{3}\left(-(2j-1)B_{1,2j-1}\sin(2j-1)\phi + 2jB_{1,2j}\cos(2j)\phi\right)}.$$

Then $\mathbf{r}(t)$ and $\dot{\mathbf{r}}(t)$ can be simply given by (ρ, μ, λ) and ($\dot{\rho}$, $\dot{\mu}$, $\dot{\lambda}$), thus obtaining $\sigma^*(t)$.

IV. Method II

This method still uses the elliptic perturbation theory, and on the basis of method I, it fully utilizes the advantages of the intermediate orbit.

Because the intermediate orbit contains the geocentric gravity and the perturbations of all the J_2 and J_3 terms and 2/3 of the J_4 terms, therefore, the remaining perturbations are small amounts of the second order or of higher orders. For example, when considering the perturbation of the shape, the perturbation function is:

$$R = \frac{1}{r}\sum_{n>4}\frac{(-J_n)}{r^n}P_n(\sin\varphi). \tag{31}$$

If we use the data of the SAO standard globe III, then

$$J_4' = -0.452 \times 10^{-6},\ J_5' = -0.235 \times 10^{-6},\ J_6' = 0.551 \times 10^{-6},$$

$$J_n' = J_n \quad (n \geqslant 7).$$

The formula for the instantaneous number of orbits $\sigma(t)$ given by method I (accurate to the second order) is:

$$\begin{gathered}\sigma(t) = \sigma'(t_0) + \sum_k (f_1)_k \Delta t_k + \sum_k (f_2)_k \frac{\Delta t_k^2}{2} + \sigma_s^{(1)}(t) + \sigma_s^{(2)}(t), \\ \Delta t_k = t_{k+1} - t_k \quad (k = 0, 1, \cdots).\end{gathered} \tag{32}$$

We can divide the perturbation terms in equation (32) into two groups. One is to put J_2, J_3 $\cdots$ and the center of gravity together and use the intermediate orbital solution. The other group is the variable terms caused by remnant perturbative factors and the combined terms of these and J_2. Thus, the computational formula (32) of $\sigma(t)$ can be changed to:

$$\sigma(t) = \sigma^*(t) + \sum_k (f_1)_k \Delta t_k + \sum_k (f_2)_k \frac{\Delta t_k^2}{2} + \sigma_s^{(2)}(t). \tag{33}$$

$\sigma^*(t)$ is the solution of the intermediate orbit, f_1, f_2 and F_0 in $\sigma_s^{(2)}$ as well as the terms related only to J_2, J_3 disappear. The terms related to J_n $(n \geqslant 4)$ can be expressed by the original perturbation formula simply by changing J_n to J_n'.

Here, two requirements must be satisfied:

One is the solution of the intermediate orbit must be simpler than the order of perturbation of the J_2, J_3 terms. This point can be clearly seen in the third section "intermediate orbital solution." But it must be noted that when computing this part, the $\sigma_s^{(2)}(t_0)$ of the remaining perturbations of the initial value $\sigma(t_0)$ provided should be eliminated.

The second is that the number of orbits needed to compute the remaining perturbations must be simply provided. Because the remaining perturbations are of the second order or of even higher orders, only the number of orbits needed to eliminate the short periodic terms of the first order in the J_2 term are necessary. This is relatively simple.

The remaining perturbative factors J_4', $\cdots$ are smaller than J_4, $\cdots$, and they already approach 10^{-7}, therefore the corresponding computational step Δtk can be increased from 2-3 revolutions to 4-6 revolutions. This method can similarly be used for first order solutions and is simpler than the first order solution of the elliptic perturbation theory.

V. Method III

This method is based on the intermediate orbital perturbation theory and uses some methods of the elliptic perturbation theory.

The six integral constants α_1, α_2, α_3, β_1, β_2, β_3 of the intermediate orbital solution are a group of regular conjugate constants. In considering the remaining perturbation, the constant transform method is used to establish equations of regular motion and the Delaunay variables are introduced similarly:

$$\begin{aligned} L &= (-2\alpha_1)^{-\frac{1}{2}}, & l &= (-2\alpha_1)^{\frac{3}{2}}(t+\beta_1), \\ G &= \alpha_2, & g &= \beta_2, \\ H &= \alpha_3, & h &= \beta_3. \end{aligned} \tag{34}$$

and the corresponding Hamilton function is:

$$F = (2L^2)^{-1} + R. \tag{35}$$

R is the remaining perburbation function.

Similarly, variables ($\tilde{L}$, $\tilde{G}$, $\tilde{H}$, $\tilde{l}$, $\tilde{g}$, $\tilde{h}$) without singularities ($e = 0$) are introduced, and similar to the method I, $\sigma_s^{(2)}(t)$ is separated by regular transform and the corresponding f_1 and f_2 are given. In the transformation process, consideration is given to the precision of the second order solution. The intermediate orbital solution can be simplified so that the corresponding results of the original elliptic perturbation theory can be fully utilized, thus reducing the complexity of computing perturbation on the basis of the intermediate orbit. The final computational formula is:

$$\sigma(t) = \sigma(t_0) + \sum_k (f_1)_k \Delta t_k + \sum_k (f_2)_k \frac{\Delta t_k^2}{2} + \sigma_s^{(2)}(t). \tag{36}$$

where f_1, f_2 and $\sigma_s^{(2)}(t)$ are the remaining perturbation terms. If we only consider perturbation of the earth's shape, then $f_2 = 0$. It must be noticed that the meaning of all σ and related quantities in equation (36) is different from the elliptic variables. They are quantities meaningful in the intermediate orbit.

For the second order solution, this method is not simpler than method II, but when it is expanded to higher order solutions, it is superior to method II. We will explain the details of method III in another article to be published and we will give a third order solution for the perturbation of harmonic terms of the earth's shape.

VI. Several Points of Clarification

1. The second order solution given by the above method has a theoretical precision that can reach 10^{-8} (the decimeter magnitude). The computed results are also the same. But the times of the numbers of orbits $\tilde{l}$ are an exception, i.e., the error along the trace is larger. This problem and the method of solution in actual work are well known and they are not explained here again.

2. Method I resulted from the direct conversion of the analytic solution of the second order. It is more convenient to use. Method II fully utilizes the advantages of the intermediate orbital solution and overcomes the two shortcomings of the original analytic method. The formulas are simple and are convenient for actual computation. Method III is even more "perfect" from the viewpoint of intermediate orbital theory.

3. The difference between this work and the work[6] by Comrade Wu Lianda [0702 6647 1129] et al is that we have mainly used a new method of exploring second order solutions and higher order solutions from the viewpoint of the analytic method. It can be seen from the above results that it is relatively convenient to solve for the second order solutions, and at the same time, because the intermediate orbit has been used, the magnitudes of the remaining perturbations are basically 10^{-7}, therefore it is easy to increase the precision from 10^{-8} to 10^{-9} on the basis of the second order solution.

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PHYSICAL SCIENCES

USE OF POLYNOMIALS TO APPROXIMATE EPHEMERIDES DISCUSSED

Beijing TIANWEN XUEBAO [ACTA ASTRONOMICA SINICA] in Chinese Vol 21 No 3 Sep 80 pp 287-292

[Article by Di Xiaohua [3695 2556 5478], Dingzhang [6405 7844 3864], Yu Zongkuan [0151 1350 1401] of the Purple Mountain Astronomical Observatory of the Chinese Academy of Sciences: "Mathematical Approximations of the Ephemerides and the Almanac for Computers"*]

[Text] Abstract

This article discusses the use of polynomials to approximate the ephemerides. A method for calculating the Chebyschev coefficients and for the best fit polynomial is given for the equally spaced tabulated numerical data, and a set of standard programs for compiling the almanac for computers is introduced.

I.

The development of computer technology has caused tremendous change in commonly used tools and methods of computation. The past method of using tables and interpolation is gradually being eliminated. Celestial positions given in equally spaced tabulated form by the ephemirides are inconvenient for use by the electronic computer or electronic calculator. It is best to use mathematical approximations based on time variables to directly compute celestial positions to replace the massive amount of tabulated data that require interpolation. In recent years, Deprit et all conducted research in this regard.[1] Starting from 1977, the United States Naval Observatory has tentatively been publishing an "Almanac for Computers"[2] that is convenient for computers. This kind of almanac for computers includes the less precise almanac suitable for navigation and the highly precise almanac suitable for astronomical studies. We used the cutoff Chebyschev series or the power polynomial as the approximation formula for determining the celestial positions within a definite time frame to provide basic data for the nautical almanac, aeronautic almanac and ephemerides.

Compared to traditional ephemerides, the almanac for computers has the following advantages: (1) it takes up less space; (2) it is easy to calculate the values of the approximation formulas by the recurrence formula method on a small computer; (3) the approximation formulas can be shortened by cutting off part of them according to the different precision required to simplify computations.

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In addition, approximation studies of the ephemerides also have great uses in space technology, automatic control of astronomical instruments and astronavigation. For example, automatic direction and tracking by large sized astronomical instruments and automatic control of positioning satellite instruments or space stations all require storing the ephemeris in a small computer. The use of a compressed form can provide a great convenience.

This article explores the method of approximating the positions of celestial bodies using polynomials. For the equally spaced tabulated data, we have used two computational methods. One is a combination of interpolation of a portion of the points and approximation spanning an entire interval to compute the coefficients of the Chebyschev series. The other method is to use the Chebyschev fitting to compute the best fit formulas. A program in BCY was set up in the TQ-6 computer to compile the almanac for computers. The computer system can also directly print out the nautical almanac and the ephemeris of the almanac for the computer.

II.

When using the nth degree polynomial $P_n(x)$ to consistently approximate a continuous function $F(x)$ in a finite and closed interval $[a,b]$,

$$\mu = \max_{[a,b]} |P_n(x) - F(x)|$$

is called the maximum deviation. The best approximation polynomial $P_n^*(x)$ of the nth degree of $F(x)$ is the polynomial in the set of approximation polynomials V_n with orders of less than n that has the smallest maximum deviation:

$$\max_{[a,b]} |P_n^*(x) - F(x)| = \mu^* = \min_{P_n(x) \in V_n} \max_{[a,b]} |P_n(x) - F(x)|. \qquad (1)$$

If F (x) represents the celestial position, then for an assigned precision of the almanac, the approximation polynomial must satisfy ε

$$\mu = \max_{[a,b]} |P_n(x) - F(x)| \leq \varepsilon, \qquad (2)$$

and the lower the degree n of the polynomial the better. Obviously, it is most ideal to use the best approximation formula to provide the approximation formula of the original precision of the ephemeris.

In actual use, the original precision of the ephemeris is not always necessarily used. It is best to cut off the approximation formula according to the different precision required. At this time, the use of the Chebyschev series to approximate celestial positions is a very good method. It can quickly converge, and it is very easy to cut it off according to the required precision. The

Chebyschev series cut off at the nth degree is very close to the best approximate formula $P_n^*(x)$, sufficient as a good approximation formula for celestial positions.

All computations of the coefficients of the best Chebyschev approximation formula or the Chebyschev expansion formula should be able to continuously compute the values of the function $F(x)$ in the approximated interval. This will cause some difficulties in actually computing celestial position. At present, the computational methods for celestial positions published in the ephemeris are of two kinds: The position of the superior planets is calculated from the equally spaced tabulated values obtained by numerical integration; the positions of the inner planets (Mercury, Venus, Mars), sun and moon are analytic expressions, but the formulas have many terms, computation is complicated, and since the computer we use does not have a dual precision operating function, and it cannot directly compute the precise position at any time from the analytic expressions. It can only compute the position of the celestial body of a fixed interval of some times (such as the zero hour of the daily almanac first, and then the position at any time is obtained by interpolation. Therefore, in actually calculating celestial positions, we can only obtain equally spaced tabulated data of the function $F(x)$. Starting out from this characteristic, we use a combined method of interpolation of partial points and approximation of the entire interval to calculate the coefficients of the Chebyschev expansion.

In addition, because the data of the celestial position we have calculated are sufficiently dense (for the sun and the inner planets, we have one value for each day, for the moon we have one value for each half day). The tabulated numerical values can be directly Chebyschev fitted, and the best fitted formulas obtained all closely approach the best approximation formulas whether in property or in precision and the method of calculation is much simpler.

Because computation of the coefficients of the Chebyschev expansion is easy, time saving, it is suitable for approximating ordinary ephemerides. For celestial bodies (such as the moon) that have a more complex visual motion, we use the best fit to reduce the number of times of approximations. In the following, the various actual methods of computation are given.

III.

In the closed interval [-1, 1], the function defined above by

$$T_n(x) = \cos (n \arccos x)$$

is an nth degree polynomial of x. It is called a Chebyschev polynomial of the first kind. If function $F(x)$ has a continuous first derivative in [-1, 1], it can be expanded over the [-1, 1] interval as a uniformly and absolutely converging Chebyschev series:

$$F(x) = \frac{1}{2} B_0 T_0(x) + B_1 T_1(x) + \cdots + B_n T_n(x) + \cdots, \tag{3}$$

The Chebyschev series converges quickly. The terms up to the cut-off term $B_nT_n(x)$ form an nth degree polynomial

$$P_n(x) = \frac{1}{2}B_0T_0(x) + B_1T_1(x) + \cdots + B_nT_n(x) \tag{4}$$

and it is generally a very good approximation polynomial of $F(x)$. After the Chebyschev coefficients are known, because the absolute value of the Chebyschev polynomial is not greater than 1, the formula

$$|P_n(x) - F(x)| = \left|\sum_{k=n+1}^{\infty} B_kT_k(x)\right| < \sum_{k=n+1}^{\infty} |B_k| \tag{5}$$

can be used to estimate the absolute error of this approximation polynomial.

Select a positive interger m larger than n, the approximate value $B_k'{}^{3}$ and B_k can be calculated by the following formula:

$$B_k' = \frac{2}{m}\sum_{l=0}^{m}{}'' F\left(\cos\frac{\pi \cdot l}{m}\right)\cos\frac{\pi lk}{m}, \tag{6}$$

In the above, Σ'' means the first and the last terms must be multiplied by the factor $\frac{1}{2}$. The relationship between B_k and B_k' can be shown to be :

$$B_k' = B_k + \sum_{l=1}^{\infty}(B_{2lm-k} + B_{2lm+k}). \tag{7}$$

When $m \rightarrow \infty$, $B_k' \rightarrow B_k$. Therefore, as long as m is chosen to be sufficiently large, the Chebyschev expansion coefficients B_k of the function $F(x)$ can be calculated directly from equation (6).

Celestial position is a function of time t. If we want to use the Chebyschev expansion to approximate it, the independent variable t has to be transformed to x in the interval [-1, 1], thus expressing the celestial position as a function $F(x)$ of x. If we want to find a suitable approximation formula for a period starting from a certain Greenwich date to day d, the zero hour of the ephemeris time of that day corresponding to the Julian day of the almanac is JED_0, then according to the following formula:

$$JED = (1 + x) \cdot \frac{d}{2} + JED_0 \tag{8}$$

The x in the interval [-1, 1] and the time JED representing the Julian day of the almanac in the approximated time interval are interchanged.

When calculating the coefficients of the Chebyschev expansion according to equation (6), the celestial position of $x_l = \cos\frac{\pi l}{m}$ must be calculated.

We used the Everett interpolation formula of quartic error (revised from the sextic error) to interpolate the celestial position.

For convenience, sometimes after obtaining the coefficients B_k of the Chebyschev expansion (4), the expansion is transformed to a power polynomial:

$$P_n(x) = A_0 + A_1x + A_2x^2 + \cdots + A_nx^n. \tag{9}$$

If we write

$$T(p, q) = \sum_{s=0}^{[\frac{p}{2}]} (-1)^s C_p^s C_s^q, \tag{10}$$

where $\left[\frac{p}{2}\right]$ represents the integer portion of $\frac{p}{2}$, C_n^m is a combined number, then the coefficients A_k can be calculated from the following formula:

$$A_k = \sum_{j=0}^{[\frac{n-k}{2}]} T(k + 2j, j) \cdot B_{k+2j}, \tag{11}$$

When the subscript of B is zero, it should be multiplied by the factor $\frac{1}{2}$.

In the best fit problem, values of the celestial position are not taken over the entire interval, but only from the point set $T = \{t_0, t_1, \cdots, t_m\}$ of tabulated numerical values. As before, the independent variable t is transformed to x by equation (8). The point set corresponding to T will be $X = \{x_0, x_1, \cdots, x_m\}$. At this time, the definition of the greatest deviation μ of the fitting polynomial $P_n(x)$ is:

$$\mu = \max_{x_k \in X} |P_n(x_k) - F(x_k)|. \tag{12}$$

Similar to the best approximation, the nth degree best fit formula has the following properties: The maximum deviation μ of the formula from the numerical values of the function occurs at at least $n + 2$ points and the signs alternate. If these $n + 2$ points are $\bar{x}_1, \bar{x}_2, \cdots, \bar{x}_{n+2}$, we have:

$$P_n(\bar{x}_k) - (-1)^k E = F(\bar{x}_k) \qquad k = 1, 2, \cdots n + 2, \tag{13}$$

$$\mu = |E|. \tag{14}$$

Therefore, if the point set $\bar{X} = \bar{x}_1, \bar{x}_2, \cdots \bar{x}_{n+2}$ can be found the linear equations (13) can be solved to obtain the coefficients of the best fit formula $P_n(x)$ and the maximum deviation μ. The point set $\bar{X}$ can be obtained from $X^{[0]}$ using the iteration process. Selection of the initial reference point set can utilize the characteristics of the Chebyschev polynomial so that they will be as close to the zero point of the function $\frac{d}{dx}\ T_{n+1}(x)$ as possible:

$$x_i' = \cos\left(\frac{n + 2 - i}{n + 1}\pi\right), \quad i = 1, 2, \cdots, n + 2. \tag{15}$$

The best fit formula $P_n(x)$ can be a Chebyschev polynomial of the form in equation (4), it can also be a power polynomial of the form in equation (9). If we use the former, the matrix of coefficients of the linear equations can be calculated by the recursive formula

$$\left.\begin{array}{l} T_0(x) = 1,\ T_1(x) = x \\ T_{n+1}(x) = 2x \cdot T_n(x) - T_{n-1}(x) \end{array}\right\} \tag{16}$$

The obvious advantage of using the power polynomial for approximation is that the computations are simple but the independence in solving the linear equations (13) is poor and tends to become sickly [sic], thus it is only suitable for use when the value of n is not large.

IV.

According to the method of computation described above, we already have a standard program for compiling the almanac for computers. We have established a BCY program for compiling the almanac for computers on the TQ-6 computer. With a given name of the almanac (such as the solar almanac, lunar almanac or almanac of superior planets), the beginning date, the length of the approximation interval and the cut off degree n, the computer can print out the coefficients and the maximum approximation error of the approximation polynomial of that almanac. If the approximation polynomial is of the form in equation (4), the computer can also give the maximum approximation deviations of different numbers p of cut-off terms ($p \leqslant n$). Here, the maximum approximation error means the maximum deviation from the data of the ephemeris of the entire approximated interval.

We computed the almanac for computers for the years 1978 and 1979 and compared our results with the "Almanac for Computers" published by the U.S. Naval Observatory. In the same approximation interval and under the same precision of approximation, the number of terms of our approximation formulas was less than that of the American ephemerides. We also calculated the almanac for computers for the entire year of 1980. For convenience, the approximation intervals used were: the stellar time of the ephemeris and solar time. For the planets, each season was given one formula suitable for use from the first day of the season to the 95th day. We have also given a low precision formula suitable for use for the entire year. For the lunar times of the ephemeris, one formula for each month suitable for use from the first day to the 32nd day was given. The following table lists the number of terms and the maximum error of the approximation formulas of the 1980 ephemeris:

Table 1

Name	Number of terms	Maximum error
World time 0 of true planet time	32	$0^{s}.001$
Nutation in right ascension	32	$0^{s}.001$
Nutation in longitude	35	$0''.009$
Nutation in obliquity	34	$0''.005$
Sun		
Apparent equatorial right ascension	21	$0^{s}.01$
Apparent equatorial declination	19	$0''.1$
Geocentric distance	23	2×10^{-7}
Radius	11	$0''.01$
Transit of almanac	19	$0^{s}.01$
Moon		
Apparent equatorial right ascension	32	$0^{s}.001$
Apparent equatorial declination	32	$0''.01$
Horizontal parallax	32	$0''.000$
Mercury		
Apparent equatorial right ascension	30	$0^{s}.02$
Apparent equatorial declination	38	$0''.2$
Geocentric distance	34	1×10^{-6}
Venus		
Apparent equatorial right ascension	21	$0^{s}.02$
Apparent equatorial declination	18	$0''.2$
Geocentric distance	15	1×10^{-6}
Mars		
Apparent equatorial right ascension	20	$0^{s}.02$
Apparent equatorial declination	17	$0''.2$
Geocentric distance	17	1×10^{-6}
Jupiter		
Apparent equatorial right ascension	14	$0^{s}.02$
Apparent equatorial declination	12	$0''.2$
Geocentric distance	17	1×10^{-6}
Saturn		
Apparent equatorial right ascension	12	$0^{s}.02$
Apparent equatorial declination	10	$0''.2$
Geocentric distance	17	1×10^{-6}

[Table 1 continued]

[Continuation of Table 1]

Name	Number of terms	Maximum error
Uranus		
Apparent equatorial right ascension	11	$0^{s}02$
Apparent equatorial declination	6	$0''2$
Geocentric distance	13	9×10^{-6}
Neptune		
Apparent equatorial right ascension	11	$0^{s}02$
Apparent equatorial declination	6	$0''2$
Geocentric distance	13	8×10^{-6}
Entire solar year		
Apparent equatorial right ascension	20	$0^{s}5$
Apparent equatorial declination	20	$2''$
Geocentric distance	7	4×10^{-5}

Accompanying Table Chebyschev approximation formula suitable for solar coordinates of three months 1980

Cumulative number of days 1 - 95; JD: 2444239.5 - 2444334.5; 1 January - 4 April

A = 47.50000000 B = -1.02105263

Chebyschev polynomial coefficients

Item Series No.	Apparent equatorial right asc.	Apparent equatorial declination	Distance	Apparent radius	Transit of almanac
0	$43^{h}8252909$	$-20^{\circ}698666$	1.98007146	$32'36316$	$24^{h}2750327$
1	3.1082617	15.049992	0.00888602	−0.14497	−0.0165087
2	−0.0932496	1.830348	0.00188878	−0.03026	−0.0925625
3	0.0117059	−0.408872	−0.00027361	0.00474	0.0120869
4	0.0043654	−0.001767	−0.00003946	0.00043	0.0042773
5	−0.0001231	0.005124	0.00000705	−0.00013	−0.0008231
6	−0.0000005	−0.001380	0.00000200	−0.00003	0.0000051
7	−0.0000231	−0.000109	0.00000318	−0.00005	−0.0000226
8	0.0000136	0.000135	0.00001830	−0.00030	0.0000217
9	0.0000704	0.000242	−0.00000508	0.00008	0.0000663
10	−0.0000163	−0.000006	−0.00001298	0.00021	−0.0000217
11	−0.0000306	−0.000115	0.00000219	−0.00004	−0.0000294
12	0.0000060	−0.000016	0.00000402	−0.00007	0.0000073
13	0.0000061	0.000033	−0.00000044	0.00001	0.0000057
14	−0.0000003	0.000006	−0.00000042	0.00001	−0.0000009
15	−0.0000012	−0.000009	0.00000007	0.00000	−0.0000003
16	−0.0000001	0.000003	0.00000016	0.00000	0.0000004
17	0.0000013	0.000001	−0.00000013	0.00000	0.0000013
18	−0.0000012	−0.000004	−0.00000045	0.00001	−0.0000010
19	−0.0000008	0.000003	0.00000013	0.00000	−0.0000016
20	0.0000015	0.000002	0.000000[illegible]	−0.00001	0.0000008
21	0.0000000	−0.000002	−0.00000005	0.00000	0.0000009
22	−0.0000008	0.000000	−0.00000017	0.00000	−0.0000003
23	0.0000000	0.000000	0.00000000	0.00000	−0.0000003

Number of terms	Cut-off error				
9	$0^{s}17$	$0''6$	$189\cdot10^{-9}$	$0'0003$	$0^{s}19$
10	0.16	0.4	63	0.0001	0.13
11	0.05	0.2	58	0.0001	0.06
12	0.04	0.2	18	0.0000	0.04
13	0.02	0.1	17	0.0000	0.02
18	0.01	0.0	7	0.0000	0.01
23	0.00	0.0	2	0.0000	0.00

We also compared the results of approximation by the best fit formula and the cut off Chebyschev series. In the same approximation interval and under the same requirements of precision of approximation, the former has one to two terms less than the latter.

Appendix

The accompanying table gives the solar almanac of the first season of 1980. The constants A, B in the table are used to translate time t of the cumulative number of days and the daily decimals to the variable x in the interval [-1, 1]:

$$x = t/A + B \tag{17}$$

where t is the ephemeris time system.

When calculating the function f(x) by the formula $f(x) = \frac{1}{2} B_0 + B_1 T_1(x) + \cdots + B_p T_p(x)$ the values of $T_i(x)$ need not be calculated because the following recursive formula can be used:

$$\begin{aligned} & C_{p+1} = C_{p+2} = 0; \\ & C_k = 2 \cdot x \cdot C_{k+1} - C_{k+2} + B_k \quad k = p,\ p-1,\ \cdots,\ 0, \\ & f(x) = (C_0 - C_2)/2. \end{aligned} \tag{18}$$

The following is an example of using the accompanying table: Compute the solar apparent equatorial right ascension of the world time $11^{\mathrm{h}}\ 59^{\mathrm{m}}\ 10^{\mathrm{s}}$ $(=0\overset{\mathrm{d}}{.}499421)$ on 21 January 1980 with a precision of $\pm 0\overset{\mathrm{s}}{.}1$. We know from the cut off error of the solar almanac that the maximum error of the series from the 0 term to the 11th term is only $0\overset{\mathrm{s}}{.}05$, satisfying the requirement. If we take the difference between the 1980 almanac and the world time to be 50^{s} $(=0\overset{\mathrm{d}}{.}000579)$, because the cumulative number of days is 21, therefore $t = 21 + 0.499421 + 0.000579 = 21.5$, thus $x = -0.56842105$.

According to formula (18), we take p = 11, and by calculation, we get

$$C_2 = -0\overset{\mathrm{h}}{.}1060547,\quad C_0 = 40\overset{\mathrm{h}}{.}2681482.$$

Therefore the apparent equatorial right ascension sought is $\alpha = (c_0 - c_2)/2 = 20\overset{\mathrm{h}}{.}1871014 = 20^{\mathrm{h}}\ 11^{\mathrm{m}}\ 13\overset{\mathrm{s}}{.}57$. The corresponding value calculated from the second degree interpolation formula for the 1980 ephemeris is $20^{\mathrm{h}}\ 11^{\mathrm{m}}\ 13\overset{\mathrm{s}}{.}56$, a very close coincidence.

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SINGLE PARAMETER METHOD TO IDENTIFY SATELLITES IN ATMOSPHERE

Beijing TIANWEN XUEBAO [ACTA ASTRONIMICA SINICA] in Chinese Vol 21 No 3
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[Article by Xu Pinxin [1776 0756 2450] of the Purple Mountain Astronomical Observatory of the Chinese Academy of Sciences: "The Single Parameter Method of Searching For and Identifying Artificial Satellites in the Atmosphere"*]

[Text] Abstract

This method uses a single parameter to express in simple terms the indefinite effect of atmospheric drag upon the motion of artificial satellites so that when the satellite is lost due to atmospheric drag, a simple and easily executed method can be used to search for and identify it.

When we start out from an accurate number of orbits of an artificial satellite at time t_0 to predict the number of orbits at time t_1, the number of orbits predicted will often be very inaccurate because of the uncertainty of perturbation of the satellite orbit due to atmospheric drag. The satellite could not be observed, or we may say, we have lost the satellite. This brings out the problem of how to search for the satellite and how to identify it after a target has been found.

To facilitate the search and identification of this satellite, we have introduced a singular variable parameter to approximate the uncertain effects of atmospheric drag. This parameter can be taken as the corrective factor of total atmospheric drag upon the satellite. It can also be taken as a certain parameter of the atmospheric mode, such as the amplitude of the variation of the total atmospheric density in an orbital day, the longitudinal difference of the peak of the orbital day from the sun, etc. Changing this parametric value will change the atmospheric drag upon the satellite within the period of time from t_0 to t_1, thus changing the number of orbits being forecast. The number of orbits obtained at time t_1 and the variation of the number of orbits are all functions of this parameter. In actual calculation, we take n + 1 discrete values within the allowable range of parametric variation and we calculate the number of orbits at time t_1 and variation corresponding to each of the n + 1 values. In this way we can separately express the number of orbits and the variations as

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the nth order polynomials of this parameter. Because the horizontal latitudinal angle of the satellite $\lambda (= \omega + M)$ is most sensitive to atmospheric drag, we took instead the n + 1 λ values as the independent variables and expressed the remaining number of orbits and variations as the nth degree polynomials of λ. Because the different values λ of time t_1 determine the different times the satellite arrives near a certain forecast position and the different positions of the observation station due to earth's rotation, therefore clearly different visual loci of the satellite can be established. This single parameter family of the number of orbits or the single parameter family of visual loci is the starting point of our search for and identification of the satellite.

To search for a satellite, we select a time t_1 near the time of the planned search. Corresponding to the allowable range of parametric variation, the value of λ that determines time t_1 is taken from the interval $[\lambda', \lambda'']$. For each λ value, the number of orbits and the variation at time t_1 can be obtained using the nth degree polynomial and any number of orbits near time t_1 can be obtained. To intercept and search, an arc perpendicular to the family of visual loci is selected on the visual celestial sphere. We figuratively call this arc a "dam." When λ in the interval $[\lambda', \lambda'']$ moves in a single direction, by moving the visual field of the observational instrument along the dam, it is possible to use one instrument over a long period of time to intercept and search for the satellite.

Most of the instruments for observing and detecting satellites are placed according to the horizontal coordinates. The horizontal longitudinal loop or the horizontal latitudinal loop should be selected as the dam so that when searching for and observing the satellite, only the instrument's angle of i elevation from the horizon and one of the azimuths have to be changed. From the number of orbits at time t_1 we can tell the dip angle i of the satellite orbit. If the latitude of the observation station is φ, then the angle of intersection of the locus of the bottom point of the satellite and the meridian of the observation station Q can be generally determined by the following formula (1):

$$\sin Q = \cos i / \cos \varphi. \qquad (1)$$

If we take Q as an acute angular value and the azimuth is counted from the north point towards the east, the rough bearing of the points of occurrence and disappearance and the highest point of the visual locus can be determined by the following table:

Item	Ascending segment	Descending segment
Azimuth of the point of occurrence	180° + Q	360° - Q
Azimuth of the point of disappearance	Q	180° - Q
Azimuth of the highest point (east loop)	90° + Q	90° - Q
Azimuth of the highest point (west loop)	270° + Q	270° - Q

The horizontal latitudinal loop near the points of occurrence and disappearance and the horizontal longitudinal loop near the highest point are all arcs that are generally perpendicular to the family of visual loci.

First let us discuss the horizontal longitudinal loop near the highest point as the dam. Let X, Y, Z represent the right angular coordinates of the geocentric equator of the observation station at time t_1. Because the highest point of the visual locus signifies that the observation station is closest to the satellite orbit, for any given value of λ,

$$\frac{\sin u}{\cos u} = \frac{Y \cos i \cos \Omega - X \cos i \sin \Omega + Z \sin i}{X \cos \Omega + Y \sin \Omega} \tag{2}$$

and

$$\frac{\sin E}{\cos E} = \frac{\sqrt{1 - e^2} \sin (u - \omega)}{\cos (u - \omega) + e} \tag{3}$$

will yield

$$\Delta t_1 = \frac{E - e \sin E + \omega - \lambda + 2N\pi}{\lambda}, \tag{4}$$

where N takes appropriate integer values so that the absolute value of the numerator in equation (4) will not surpass π. At time $t_2 = t_1 + \Delta t_1$, the satellite is even closer to the highest point than at t_1. Using t_2 to replace t_1, and by repeating the above process, we can obtain t_3, and by many repetitions we can obtain t_k. Because the horizontal longitudinal loop taken as the dam is given by the predetermined azimuth near the highest point, but not equal to the highest point, thus, to obtain the time the satellite passes the dam, the visual position and the visual angular velocity still have to be obtained from the number of orbits at time t_k. Dividing the positional difference between the visual position and the dam by the component of the bearing of the visual angular velocity gives us a new time difference Δt_k and an approximate time of passing the dam $t_{k+1} = t_k + \Delta t_k$. Using t_{k+1} to replace t_k, and by repetition, we can obtain t_{k+2}, and this process can be continued until the difference between two neighboring substitutions is sufficiently small. The final angle of elevation from the horizon of the visual position gives the position where the satellite passes through the dam.

Because the larger values in the interval [λ', λ"] corresponds to earlier passings of the satellite, therefore we begin from λ" and gradually reduce the value of λ. We select an appropriate δλ, we can use numerical computation to obtain the spherical surface distance δL of the position of passing of the dam by the satellite corresponding to λ" and λ" − δλ. Let the effective diameter of the visual field of the observational instrument be D, let $\Delta\lambda = D/\left|\frac{\delta L}{\delta \lambda}\right|$, then the position of passing the dam by the satellite corresponding to λ" and λ" − Δλ differs by about D. Repeatedly using λ" − Δλ to replace λ", we can successfully obtain a series of positions on the dam and the corresponding times. The spherical surface distance between each pair of neighboring positions is approximately equal to D. In searching for the satellite, we need only to place the center of the visual field of the instrument at the center of each pair of neighboring positions and wait for the satellite at the time between the two corresponding neighboring times.

Sometimes, not the entire interval $[\lambda', \lambda'']$ is significant in waiting. For example, some of the values of λ can give the visual positions below the horizon. When optical observational instruments are used, if the sunshine upon the satellite or light from the sky above the observation station is not suitable, there is not meaning in waiting.

If we select the horizontal latitudinal loop near the points of occurrence and disappearance as the dam, then the position of passing the dam by the satellite should be changed and represented by the azimuth, and the above computational procedures should be revised as follows: Let h be the angle of elevation of the horizontal latitudinal loop, r and R be the geocentric distance of the satellite and the observation station respectively,

$$\sin \Delta u = \frac{\cos h}{r}\left(\sqrt{r^2 - R^2\cos^2 h} - R\sin h\right), \tag{5}$$

We take acute angular values for $\Delta\mu$, and replace μ in equation (3) by $\mu - \Delta\mu$ and $\mu + \Delta\mu$ for the point of occurrence and the point of disappearance respectively, and the component of bearing and the positional difference are replaced by the component of the angle of elevation of the visual angular velocity and the difference in the angle of elevation between the visual position and the dam.

When a target has been found, it has to be identified to see if it is the satellite belonging to the set of numbers of orbits at time t_0. If many pieces of observed data are gathered, we can use the common calculations for the initial orbit or the method of computing the improvements of the orbits to compute the orbit, and the epochal time of the number of orbits obtained is used as t_1, and the horizontal latitudinal angle λ obtained is used to form $\lambda_k = \lambda + 2\,k\pi$, k takes all the integer values that satisfy the inequality

$$\lambda' \leqslant \lambda_k \leqslant \lambda'' \tag{6}$$

We substitute λ_k into each of the nth degree polynomials to determine the theoretical values of each of the remaining number of orbits and we compare them with the computed values for identification. If the value of k differs by 1, the number of orbits of the satellite about earth differs by one whole revolution. The value of k that enables the theoretical and the computed values to coincide the best should be taken.

If only one piece of data is obtained, we can let the observational time be t_1. Let $\frac{1}{2}(\lambda' + \lambda'')$ be the first rough estimated value of λ, substituting into each of the nth degree polynomials to obtain the number of orbits, and from (2) and (3) we can obtain E, and let

$$\lambda_k = E - e \sin E + \omega + 2\,k\pi, \tag{7}$$

k takes all integer values that satisfy (6) and (7). After substituting λ_k into each of the nth degree polynomials to obtain the number of orbits and the variation, the geocentric equatorial right angular coordinatex x, y, z of the satellite at time t_1 can be obtained from the formula (2) for the binary problem in celestial mechanics, the linear velocity V and the three cosines α, β, γ, of the direction of the linear velocity. In this way, we will have two spatial straight lines: one is L_1 that passes through the point (X, Y, Z) along the observational direction (A, B, C). The other is L_2 that passes through point (x, y, z) along (α, β, γ). These two straight lines clearly have one common perpendicular line. Let the coordinates of the intersection of the common perpendicular line and line L_1 be

$$(X + A\rho_1,\ Y + B\rho_1,\ Z + C\rho_1),$$

the coordinates of the intersection of the common perpendicular line and line L_2 be

$$(X + \alpha\rho_2,\ y + \beta\rho_2,\ z + \gamma\rho_2),$$

then from the property of the common perpendicular line we know that

$$\rho_1 = \left[\begin{pmatrix} x - X \\ y - Y \\ z - Z \end{pmatrix} \times \begin{pmatrix} A \\ B \\ C \end{pmatrix}\right] \cdot \left[\begin{pmatrix} A \\ B \\ C \end{pmatrix} \cdot \begin{pmatrix} \alpha \\ \beta \\ \gamma \end{pmatrix}\right] \Big/ \left|\begin{pmatrix} A \\ B \\ C \end{pmatrix} \times \begin{pmatrix} \alpha \\ \beta \\ \gamma \end{pmatrix}\right|^2. \tag{8}$$

Let $d\lambda = \rho_2\dot{\lambda}/V$, substitute λ_k by $\lambda_k + d\lambda$, repeat the above computations, repeat iteration until the absolute value of $d\lambda$ is sufficiently small.

By using the final number of orbits obtained from iteration, we can obtain

$$\rho_1 = \left[\begin{pmatrix} x - X \\ y - Y \\ z - Z \end{pmatrix} \times \begin{pmatrix} \alpha \\ \beta \\ \gamma \end{pmatrix}\right] \cdot \left[\begin{pmatrix} A \\ B \\ C \end{pmatrix} \times \begin{pmatrix} \alpha \\ \beta \\ \gamma \end{pmatrix}\right] \Big/ \left|\begin{pmatrix} A \\ B \\ C \end{pmatrix} \times \begin{pmatrix} \alpha \\ \beta \\ \gamma \end{pmatrix}\right|^2 \tag{9}$$

and the directional length of the common perpendicular line,

$$l = \begin{pmatrix} x - X \\ y - Y \\ z - Z \end{pmatrix} \cdot \left[\begin{pmatrix} A \\ B \\ C \end{pmatrix} \times \begin{pmatrix} \alpha \\ \beta \\ \gamma \end{pmatrix}\right] \Big/ \left|\begin{pmatrix} A \\ B \\ C \end{pmatrix} \times \begin{pmatrix} \alpha \\ \beta \\ \gamma \end{pmatrix}\right|. \tag{10}$$

If for all values of k, all the arc values represented by $\left|\frac{l}{\rho_1}\right|$ surpass the error range of the measured angle, this indicates that the observed satellite is not the one desired.

If besides the measured angular data there are also measured data of the slant distance, we can compare the actually measured slant distance and ρ_1 as another reference for identification.

The method described in this article has already been utilized in the actual work of forecasting of satellites (sic satellite orbits). The actual work of many years of all the comrades of the forecasting group have provided the practical foundation for the thoughts of this article.

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CONFERENCE TO APPROVE TRIAL EDITION OF FLIGHT QUALITY STANDARDS MANUAL

Beijing GUOJI HANGKONG [INTERNATIONAL AVIATION] in Chinese No 1, 1981 p 29

[Text] The fourth session of the CAE Aerodynamics Group Conference was held in Shanghai from 18 to 23 September 1980. The conference was attended by over 60 experts, professors, engineers and related engineering technicians and leading technical cadres from research, production, user organizations, institutes and schools.

The chief purpose of the conference was to examine and approve the trial edition of the PRC's "Military Aircraft Flight Quality Standards." At the same time, the group's short-term projects and long-term scientific research programs were planned (including plans for external activities).

Since the group was established in 1977, various member units were formed to study the U.S. "Military Standard--The Flight Quality of Piloted Aircraft" [MIL-F-8785 B (ASG)] and related flight quality standards in Britain, France, the USSR and Sweden. Test calculations were made on present PRC aircraft based on various indices of U.S. Standards. The PRC's experience in aircraft research and development was summarized and theoretical research and flight-test studies were carried out. The trial edition of "Military Aircraft Flight Quality Standards" was compiled on the basis of these studies and the actual status (of aircraft) in the PRC. After more than 3 years of joint effort and close cooperation with various units from research, production, user organizations and schools and institutes and after many academic exchanges, investigative research, discussions and revisions, the compilation work on all the chapters and sections of the trial edition of "Military Aircraft Flight Quality Standards" has basically been completed. When the book is reviewed and approved at the conference, it will undergo the appropriate revision and overall editing and be submitted to a leading higher authority for approval, after which it will be issued for trial use.

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APPLIED SCIENCES

CONFERENCE REVIEWS CHINESE ADVANCES IN FIRE-CONTROL TECHNOLOGY

Beijing GUOJI HANGKONG [INTERNATIONAL AVIATION] in Chinese No 1, 1981 p 17

[Article: "CAE Conference on Airborne Fire-Control Systems"]

[Text] A conference to exchange scientific information on airborne fire-control systems was held by the China Aeronautical Establishment [CAE] in Beijing from 14 to 20 October 1980. One hundred sixteen delegates attended the conference representing concerned sectors of the aviation industry, the Air Force, the Navy, high-level institutes and schools and other industrial organizations. A total of 75 academic papers were submitted and of these 56 were presented to the conference or at seminars. The report [papers] covered the principles of advanced fire-control systems and the results of related research on the new technology of fire-control systems, summing up the experiences and lessons China has gained in the research, production and application of fire-control technology. The consensus is that the academic papers basically reflect the present level of airborne fire-control technology in the PRC although some papers were more advanced.

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DEVELOPMENT OF CONSTRUCTION MACHINERY INDUSTRY REVIEWED

Tianjin GONGCHENG JIXIE [CONSTRUCTION MACHINERY] in Chinese No 1 1981 pp 1-3

[Article by Xu Wei [6079 0251]: "Views on the Development of Construction Machinery in Our Nation"]

[Text] In our nation's machinery industry, construction machinery is a profession that has developed relatively late and the foundations are relatively weak. Not long after development, it encountered the "10 years of chaos," it suffered several difficulties, many losses and destruction. After crushing the "gang of four," under the efforts of comrades of the factories, research institutes and academies and schools, the industry was reorganized and revived and some new developments have been realized. But because the industry was being busily reorganized and production was being increased and with the long period of being "closed" to the outside, efforts to study and to grasp learning and utilizing the advanced experience of foreign nations to hasten its own development by specifically pinpointing the characteristics of the industry and the actual situation were insufficient. Thus, the industry could not meet the needs of varieties, quality and standards of the various departments of the national economy.

Internationally, after World War II, construction machinery has been a manufacturing industry that has developed relatively quickly. The market is also broad. Such machinery is needed in energy exploitation, mining, highway and seaport construction and building construction. Take Japan for example, during the 10 years from 1960 to 1970, the number of factories increased by one and a half times. Staff and workers increased by onefold, sales increased nearly seven times, varieties became plentiful, and the industry became more and more specialized. Our nation has a large population, but we must never believe that because there are more people the development of construction machinery can be slow. In moving, digging, lifting, installing and shoveling operations, there is a lot which cannot be replaced by manpower. Even when machinery can be replaced by manpower, there is still the problem of having too many people at the construction site and therefore work cannot proceed. Viewing the need for expanding the export of machinery products in the international market, construction machinery is a product that has wide uses and demands. Therefore, construction machinery is still a product that has a demand and a future in domestic and foreign markets and it should be developed. At present, during the period of adjustment, some construction machinery is not selling well. The problem is not that nobody wants such machinery. The main reason is that the varieties presently available are not complete, the quality is low, the prices are slightly higher, and the products do not suit the needs of the market. There is also a definite number of construction machinery that has to be imported. This shows that our development is not rapid and is not good and we must hasten to catch up in development.

Why has construction machinery developed rapidly abroad? There are many reasons. The main reasons are that other people's products are designed as a series of products and as general purpose products with a high degree of standardization. There are conditions for the organization of mass production and the production of multiple varieties on the foundation of specialization. Products for moving, digging, lifting, installing and shoveling are complete in varieties and specifications. Advanced technological methods and facilities can be used to assure quality of products and control costs so that the products are competitive in the market. The relatively well-known manufacturers such as Caterpillar of the United States and Komatsu Manufacturing Company of Japan generally developed along this path. Why is our development not rapid and not good? There are also many reasons. The main reasons are that we did not establish a correct leading ideology oriented toward the characteristics of this industry and its products. Factories are almost omnipotent. Each factory struggles on its own. The degree of standardization, general applicability and serialization of the design of the products is very low. There is no way to organize specialized production of many varieties and mass production, and advanced technological methods and facilities cannot be used. The result is that to develop each variety, everything has to be done from the start. Progress is very slow, the quality is not stable, the cost is high, and the competitive ability in the domestic and foreign markets is very low. Therefore, to hasten our nation's development of construction machinery, we must learn from the good points of others, overcome our own shortcomings, and correct the leading ideology.

After the ideology has been set straight, we must not jump ahead in big leaps. We must begin at the bottom and start out from the actual situation and proceed step by step.

First, We Must Conscientiously Reorganize the Present Products

The presently available products must be conscientiously reorganized to assure product quality so that one unit will be able to replace another. This concerns the question of whether the already established market can be solidified and the reputation in the market. Most of the products presently available are of lower standards when compared to more advanced foreign products. But the old must not be discarded. Before any new products can definitely and confidently replace the old, the products that cannot be eliminated within a short period must be improved on the basis of reorganization according to actual experience, like the popular saying, "One must have a horse before one can eliminate the donkey." Some new products are not completely new inside and out but come about as a result of step-by-step improvement and changes from quantity to quality.

Second, Develop Variations and Attachments on the Basis of Presently Available Products

Most of the presently available products are single job equipment and dedicated machinery. Bulldozers can only be used for moving earth, shoveling machinery can only shovel. There are no variations. The machinery lacks attachments. The uses are limited, the machinery cannot suit the needs of the market and the sales are affected. This problem must be quickly solved and there is the possibility of solving it. A piece of construction equipment can generally be divided into a power and transmission component, a frame, a mobile part, a hydraulic system, and an operational component. Within the same power range, the frame and the operating component can be changed and the structure and setup can be readjusted so that there is the possibility of developing a variation on that one foundation. The different construction machinery manufactured by different European manufacturers use mostly the diesel engine manufactured by the Daoyizi or Camingsi companies. Most of the gear boxes are manufactured by the ZH Company. Most of the hydraulic components are manufactured by the Linte and Haizuomadike Company. The ratio between in-house manufacturing of the main frame and purchased parts is about one half. This is the reason. Attachments are the variable operating parts equipped on one piece of machinery, such as equipping the loader with a shovel which can load loose cargo and with a fork to load timber. Dredging equipment manufactured by European manufacturers is equipped with a forward shovel, a reverse shovel, a grip, a fork, a hook and many attachments which can be purchased selectively. Developing variations and attachments to the presently available products to expand their uses and to better meet the needs of the market is equivalent of increasing the varieties.

Third, Digestion of Introduced Technology Must Be Grasped Well

Although introducing needed advanced technology from abroad is costly, doing it well can save us some time in catching up. The key is to grasp tightly the digestion of introduced technology. The presently available technology has already been introduced. Some technologies are being negotiated. Digestion of introduced technology has already become a matter of daily importance. Simply introducing technology without digestion will not serve to grasp the other's technology well and will not elevate our standards. The final goal of digesting introduced technology is to "know it and to know how it works," and at a certain time, we can develop our own technology so that "the student learns from the teacher and becomes better than the teacher." The first step is to learn exactly from the introduced design and technology and not make changes. Only in this way can the products manufactured exactly according to the introduced technology be tested. Then, a series of tests, experiments and comparisons must be carried out to "understand the why." Efforts must be exerted to carry out detailed and hard work. If we only know how to introduce technology but do not grasp it tightly and digest it, we will only be able to permanently follow behind others.

Fourth, Take the Initiative To Establish Technical Services

For a long time, we have treated products that have left the factory like "daughters who have been married and are like spilled water." No further care is taken. When the products develop quality problems and when the user complains, we do not pay any attention and there is absolutely no concept of service. Capitalist factories emphasize after-sales service. One reason is not to create a bad reputation in the market, and the second reason is that more business can be made by providing spare parts, components and maintenance services. The third reason is that the consumer's feedback and needs can be gathered through technical services and fed back into product design and technology for continued improvement to strengthen one's own competitiveness. This point coincides with the theory of pragmatism and the theory of knowledge. In recent years we have begun technical service work. Many factories have conducted training classes for consumers to train maintenance and operational personnel. The supply of accessories has improved from the past. Some factories have also launched maintenance operations. But the problem is that self-consciousness and initiative are insufficient. Some comrades even view these as temporary measures when sales are down and work is slack. Recognition in this regard must be improved. The technical services welcomed by the users must be provided persistently and perfected continuously. Each factory must join with others to establish a service network for construction machinery. Ways must be sought to grasp the operating experience of the consumer and the problems exposed in operation. This makes it easy for the consumer, establishes a reputation and helps realize continuous improvement. We have a socialist enterprise and there is absolutely no reason to provide less satisfactory technical service than capitalist factories and enterprises.

Fifth, Improve the Technological Standards Step by Step

Capitalist factories and firms pay a lot of attention to the improvement of technological standards. They acquire product quality and make their cost competitive through technology and gain more profit. At present, the more common technological means is reflected in the higher and higher proportion of welding structures, the use of high strength steels as much as possible, the continuous improvement of the precision of semifinished products to reduce the amount of cutting. Metallic parts are made mainly by punching, new heat treatments are used to improve the wearability of spare parts, and there are more and more numerically controlled machine tools, flow processing lines and automated processing lines. Because of our original foundation and limits on mass production, advanced foreign technology cannot be completely relocated and copied at once. And at the same time, we do not have that much capital. We must proceed step by step. First we must obtain the necessary technological means and methods to assure product quality. We must not make do with makeshift. Then, as the demand for mass production increases, we can engage in high efficiency technological means and methods. We must start out from the actual situation in each factory and we must consider economic results.

Sixth, Start Out by Producing Series of Components and Spare Parts, Making General Purpose Products, Standardizing Products

This work must be grasped, otherwise the backward situation of our nation's construction machinery cannot be thoroughly changed. It must be grasped. We can refer to the international experience of dividing construction machinery into two major categories: belt driven types and gear driven types. Each category can be further divided into several subcategories according to the power range. We can select several common, basic spare parts and components to design according to the principles of serialization, general purpose orientation and standardization. The entire work must proceed from the profile to the detailed. On a foundation of summarizing domestic and foreign experience, and by analysis and comparison, we can foment conditions on a wide basis and draw up plans. Then we can proceed to design, test, experiment, evaluate and revise according to plan and carry out these links many times over until we establish a fixed model. After the basic spare parts and components are serialized, general purpose oriented and standardized, there will be a foundation for development of varieties. Organization of specialized mass production will have a prerequisite. This is the road that must be followed.

Seventh, Place Experimental and Research Work in an Important Position

Realizing the four modernizations and engaging in industries require science and depend upon data. The efforts must be tested by practice. One cannot depend upon subjective wishes and the pace of the leadership. Factories, research institutes and academies and schools must all place experimental and research work in an important position. Manufacturing departments must establish tests for testing the function of the entire machine and spare parts. Design and scientific research departments must establish tests to test the structure, quality of materials and life of the entire machine and the spare parts. They must join together to carry out evaluation of new types of machinery and comparative tests of prototype machinery produced domestically and abroad. Each unit must fully utilize the presently available conditions, each has its own emphasis, each supplements the other, and one must be willing to invest in experiemental and research work. To hasten the development of our nation's construction machinery, besides correcting the leading ideology, distributing the work well, organizing coordination and compatibility well, experimental research work is a foundation. Otherwise, everything is just empty talk.

Eighth, We Must Be United

Everyone wishes to hasten the development of our nation's construction machinery but there is a series of actual work that must be done. To rely on others and to live off what is available cannot be done. Conversely, to want to create everything but not to join together will not work either. Because of historical reasons, there is no unit at present that has developed into a relatively complete unit in construction machinery manufacturing. Each unit has its own specialties and its own shortcomings. Without joining together, the forces cannot be centralized and the specialties cannot be developed to supplement the shortcomings. Factories, research institutes and academies and schools must join together. The units engaged in the design and manufacturing of the main frame and the coordinating units engaged in developing accessories must join together. The manufacturing departments and the consumers must join together. Various different forms of joint ventures should be carried out using economical methods on a voluntary and mutually beneficial basis according to the different jobs. To coordinate the work of the entire industry, the situation can be created to organize on the basis of voluntary participation a civilian (or semi-official) national association which is nonprofit oriented. A charter can be written up democratically. The board can be elected democratically; a council can be formed. Everyone should follow what has been agreed. Rewards can be given to those who exert efforts and those who are benefited. Maybe this is the way.

The above opinions are not inclusive of all aspects of the work, and they may not be correct. They are shallow opinions formulated on the feelings felt in the performance of several important jobs and selected as an attempt to offer a few commonplace remarks by way of introduction so that others may come up with valuable opinions. It is hoped that everyone can explore the problems and provide plans for hastening the development of our nation's construction machinery.

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BRIEFS

SCIENTIFIC AND TECHNOLOGICAL NEWS--Beijing, 2 May (XINHUA)--The Chinese Academy of Meteorological Science, the Shanghai Supersonic Instrument Plant, the Shanghai Yawu Radio Plant and the Changzhou Meteorological Research Institute have worked in cooperation and manufactured a supersonic wave pressure meter. It is useful in atmospheric pressure survey and other economic construction work. The Wuhan Seismological Research Institute recently successfully produced a JCY-3 type precision laser range finder for use in the study of earthquakes and geology. The Chinese Academy of Meteorological Science has successfully produced a radium standard monitoring instrument for use in the survey of uranium deposit and other purposes. Its variation in measuring 20 mg pack of radium is 0.02 percent. [Beijing XINHUA Domestic Service in Chinese 0210 GMT 2 May 81 OW]

LIAONING ELLIPTICAL PRODUCTS--LIAONING KEJI BAO on 7 May frontpages a newsletter introducing the story of (Yang Maojun), a scientist at the Shenyang No 601 Research Institute, who developed the theory of planetary ellipse. This important theory on ellipse locus [tuo yuan gui ji] is of great academic and practical value. Since 1980, two special elliptical mechanisms have been manufactured which can help raise productivity by scores of times. This theory will also help open new horizons in the production of elliptical loudspeakers for radio and television sets, elliptical ball bearings [tuoyuan xing gundong zhou cheng] for the main shaft of aircraft engines, elliptical oil pumps and other elliptical-shaped products. [Shenyang Liaoning Provincial Service in Mandarin 2200 GMT 6 May 81 SK]

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PREVENTION OF CANCER-CAUSING NITROSAMINES RESEARCHED

Shijiazhuang HEBEI RIBAO in Chinese 28 Feb 81 p 4

[Article by Zhang Zhendong [1728 2182 2639], Professor of Hebei College of Medicine]

[Text] Since the discovery of the carcinogenic action of nitrosamine compounds in 1954, the subject has attracted considerable attention and some preliminary results concerning the carcinogenesis of nitrosamines and its prevention have been obtained in these 20 plus years.

Carcinogenesis of Nitrosamines

In the 1960's, research dealt mainly with the chemical structure, types, and formation of nitrosamines and experimental induction of cancer with nitrosamines. To date, nearly 100 types of nitrosamine compounds are known. They belong chiefly to the two types of symmetrical and asymmetrical nitrosamines. Nitrosamines are formed by nitrous acid and amines in food or beverage under a given condition. Nitrous acid and amines may also enter the human stomach or the human urinary system to synthesize into nitrosamines.

Nitrous acid and amines are often observed in polluted water and molded foods. American scientists, in the process of inspecting foods, discovered the existence of nitrosamines in dried beef, salted pork and cured ham. They also pointed out that nitrosamine is formed from combining nitrous acid (which is a preservative and also acts to keep meats in red color) with the organic amine in the meat. When nitrosamines are administered to animals through injection, pouring down the stomach, or drinking, they can induce many types of tumors in frogs, fish, mice, rats, guinea pigs, rabbits, pigs, dogs and monkeys. Of these nitrosamines, the symmetrical nitrosamines induce mainly liver cancer in these animals and the asymmetrical nitrosamines mainly esophageal cancer. As nitrosamines can induce various types of animals to have cancer, it is very possible that they can induce cancer in humans. Moreover, as nitrosamines induce mainly liver and esophageal cancer in animals, scientists begin to pay attention to the relationship between nitrosamines and human liver as as esophageal carcinomas.

The essential method of studying the relationship between nitrosamines and human carcinomas is to examine the existence of nitrosamines in human foods and beverages in regions of high incidence of carcinomas, and to determine the cancer inducing action of these nitrosamine--containing foods and beverages in animals. Results of these studies can perhaps explain that nitrosamines are possibly the cause of human esophageal carcinomas.

In the past few years, therefore, the target of research here and abroad, concerning the pathogenesis of esophageal cancer is the existence of nitrosamines in the foods and beverages of peoples in high incidence areas. For example, in the area of high incidence of esophageal cancer in north Iran, nitrosamines were found in grains. The incidence of esophageal cancer is high in the northwestern part of France where the people are fond of a certain liquor made of rotten apples. After examination, it has been determined that that liquor contains nitrosamines. The scientists of these countries believe, however, the nitrosamine contents in these foods and beverages are very little, insufficient to cause cancer in humans. In North China, the area to the south of Taixing Mountains is a high incidence region of esophageal cancer. Gastric cancer, liver cancer and lung cancer are not rare either. Chinese scientists carried out a great deal of studies on the cereal foods, drinking water, dried sweet potatoes, dried radish and pickled cabbage of the region and have proved that all of these are carcinogenetic. Examinations of the cereal foods, drinking water and pickled Chinese cabbage of high incidence region demonstrate that their nitrosamine contents are obviously higher than those in the regions of low incidence of esophageal cancer. Nitrosamines found in the studies include dimethylnitrosamine, diethylnitrosamine and methlbenzylnitrosamine. When the drinking water or foods in the region of high incidence of esophageal cancer were fed to animals, cancer of the esophagus, the forestomach (corresponding to the extension of the human esophagus) and other organs was induced. For this reason, it is believed that nitrosamines are perhaps the major reason for the high incidence of esophageal cancer in the region south of Taixing Mountains in North China.

Prevention of Cancer-causing Nitrosamines

Nitrosamines may be the cause of human esophageal cancer and other malignancies. Researches have been carried out on preventing nitrosamine induced carcinomas. Based upon the results of these studies, there are two preventive measures:
(1) With the bacterial mutation method, it has been discovered that juice of some vegetables, such as round cabbage, cauliflower, lettuce, radish cryptotaenia, Chinese alpine weed [Eulaliopsis binata], bean sprouts, pumpkin and green peas, etc. can turn nitrosamines into noncarcinogenic substances. The reason is perhaps that these vegetables contain certain enzymes which are capable of decomposing nitrosamines, or perhaps there may be some other reasons which cause the carcinogenic action to stop. According to the above studies, people in the areas of high incidence of cancer should not eat pickled cabbage and especially should not drink the soup of pickled cabbage, should not eat dried radish which molds easily and should eat more fresh vegetables, especially raw radish, round cabbage, etc. In this manner, the nitrosamine content of pickled cabbage and dried radish are eliminated while the nitrosamine contents of other foods are also destroyed. The physical chemical characteristic of nitrosamines is that it decomposes easily in sunlight. When this characteristic is used to carry out experiments with reducing the carcinogenesis of nitrosamines with sunlight, it is discovered that after water solution of nitrosamines is exposed to sunlight for 7 hours before it is fed to mice

and rats, the esophageal and liver cancer induction rate may be reduced 70 to 90 percent, compared with that of nitrosamine solution without exposed to sunlight. These experimental results demonstrate that sunlight exposure may be used as a method of prevention. Areas of high incidence of cancer should promote sunning cereal grains, flour and drinking water so as to destroy nitrosamines and reduce the incidence of carcinomas.

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BRIEFS

ACUPUNCTURE TO TREAT ICTEROHEPATITIS--Victims of acute icterohepatitis need not be afraid. There is no need to administer any drugs; acupuncture can cure it. This is the result of 10 years of scientific research and experimentation carried out by the hospital attached to the Hubei College of Chinese Traditional Medicine. Not so long ago, delegates participating in the appraisal conference on the result of this scientific research came to the hospital to observe the acupuncture performance and to visit the patients. Twenty-four-year old Liu Guanghan [0491 0342 3352], a worker of the Wuchang Jiyuqiao Bean Products Plant, Wuhan City said: "One day I suddenly felt dizzy and had a fever; my limbs were weak; my belly was full; and I did not feel like eating or drinking. A few days later, my urine was as yellow as strong tea; and my eyes turned yellow also. After examination, it was found that I had acute icterohepatitis." Then, he pointed to the needles that were vibrating slightly on the back of his feet and legs saying: "From the very beginning, the doctor did not feed me drugs; he just treated me with acupuncture. I did not believe him, but just sort of accepted the treatment. After 3 days of acupuncture, I felt like eating. Now, I can eat and sleep. The color of my urine also gradually turned to normal." The general secretary of the Cloth Machine Shop of Wuhan State-operated Cotton Mill No 6, Xu Shunbao [1776 7311 0202] said: "I was sick just like Liu and came to the hospital on the same day. As soon as the needles were put in, my belly felt very comfortable. My illness is much better and it has not been even half a month." Acute icterohepatitis is a common disease and it occurs frequently. Aside from common Western and Chinese traditional drugs, there is no specially effective drug for it. In 1970, the Hospital of Hubei College of Chinese Traditional Medicine, Hepatic Disease Group began to study its acupuncture treatment method. In these 10 years, 411 cases have been treated, and the cure rate is 81.4 percent. Why is it that acupuncture can cure acute icterohepatitis? Chinese traditional physicians believe this disease is mainly "an accumulation of damp heat in the liver and gall bladder"; therefore, in treatment, acupuncture should be administered in the Yanglingquan Point on the back of the foot, the Zusanli Point of the leg, and the Hegu Point on the hand because these are points of the liver and gall bladder, so as to relieve fever and dampness. Just as in acupuncture anesthesia, if theory is to be combined with practice to answer the question of why can acupuncture cure icteric hepatitis, further study and investigation are needed. [Text] [Shanghai WEN HUI BAO in Chinese 16 Feb 81 p 1] 6248

CONGENITAL DEFORMITY RESEARCH--Hospital No 1 of Wuhan College of Medicine was the first to use Chinese made trypsin to proceed with the technique of successfully displaying a human chromosome. This technique is important for diagnosing congenital deformity and retardation of the fetus before birth as well as for determining malignant blood diseases. The chromosome banding display technique is to enable the banding characteristic of the cell nucleus of chromosomes to be observed. Children growing up to look like their parents is because of the genes in the chromosome they inherit. Chromosomes appear only during cell division. If there is an aberration in either the number or the shape of the chromosome, deformity, retardation, and other forms of hereditary and serious diseases will occur. Generally, chromosomes can only be observed in groups, and it is not easy to discover any breakage, translocation, and other anomalies. Since 1978, on the basis of learning from related domestic and foreign experiences, the Hematology Laboratory and the Cell Genetics Experimental Laboratory of the Department of Pediatrics proceeded with repeated experimentations. To date, more than 170 cases of congenital deformity and retardation and more than 30 cases of leukemia have been examined with the technique and the results have been satisfactory. [Text] [Wuhan HUBEI RIBAO in Chinese 23 Jan 81 p 1] 6248

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Microcutting and Superfinish Turning Method......Wu Yongxiao [0702 3057 1321], Precision Instrument Technology Teaching and Research Group (56)

Inventory Control and the Application of Computers to Inventory Control......Ma Tianchao [7456 1131 6389], Hong Guofang [3163 0948 5364], Fang Shufen [2455 3219 5358] and Gao Yonghui [7559 3057 1979], all of the Production Organization Teaching and Research Group (78)

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Determination of Molecular Weight of Polymers by Low Angle Laser Light Scattering......Ying Qicong [2019 3823 3827], Chen Guoqing [7115 0948 1987] and Huang Lirong [7806 7787 2837], all of the Institute of Chemistry, Chinese Academy of Sciences (24)

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A Study on the Separation and Purification of Neptunium in the Purex Process......Jiang Hao [3068 3185], Qiu Xiaoxi [6726 1321 3588], Bao Mengxiong [7637 1125 3574], Zhu Jianmin [2612 0256 3046] and Zhu Hanmin [4376 3352 3046], all of the Institute of Atomic Energy (12)

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Northwestern Institute of Nuclear Technology (34)

The Determination of Trace Amounts of Cobalt and Nickel in Reactor Loop Washing Liquids by Catalytic Polarography......Li Kaihua [2621 7030 5478], Wang Xuezhen [3769 1331 2182] and Li Jifu [2621 7162 4395], all of the Institute of Atomic Energy, Beijing (42)

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Quantitative Determination of ^{97}Zr(^{97}Nb) by the Radioisotopic Dilution Method with ^{95}Zr as Diluent......Cui Huanhua [1508 3183 5478] and Feng Xizhang [7458 6932 3864], both of the Institute of High Energy Physics, Chinese Academy of Sciences, Beijing (51)

Separation of Lanthanides by the Method of Ion Exchange-Organic Extractant Elution......Jiang Lingen [3068 2651 2704], Gao Ying [7559 4481] and Liu Xinqi [0491 2450 6386], all of the Department of Technical Physics, Beijing University (55)

Low Temperature Adsorption of Radiokrypton on Activated Charcoal in the Presence of Nitrogen and Hydrogen......^{85}Kr Research Group, Shanghai Institute of Nuclear Research, Chinese Academy of Sciences (60)

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AUTHOR: HE Guangqian [0149 1639 0051]
ZHOU Runzhen [0719 3387 3791]
LIN Chunzhe [2651 2504 0772]

ORG: All of the Chinese Academy of Building Research

TITLE: "Application of Spline Function Method to the Solution of Plates and Shells"

SOURCE: Beijing JIANZHU JIEGOU XUEBAO [JOURNAL OF BUILDING STRUCTURES] in Chinese Vol 2 No 2, 5 Apr 81 pp 1-9

TEXT OF ENGLISH ABSTRACT: In this paper, the cubic B-spline is used as the piecewise function for the solution of regular form plates and shells commonly used in engineering construction. Based on the variational principle of the potential energy of plates and shells, the total stiffness matrix for bending or for plane stress of plates or that for stress and deformation of shells can be formed with its coefficient matrices in explicit forms. Compared to the ordinary finite element method, the prominent features of the method given in this paper are its higher accuracy, more economical in computing storage and time, and ease in programming. Because a single computational scheme can be used both for plates and for shells, it has been found to be very convenient in application. As verified by actual computations, the accuracy of the method can well meet that deemed necessary for engineering designs.

AUTHOR: TANG Limin [0781 4539 3046]
CHEN Wanji [7115 8001 0679]
LIU Yingxi [0491 6601 2569]

ORG: All of Dalian Institute of Technology

TITLE: "The Quasi-conforming Element Method for Thin Plate Bending Analysis"

SOURCE: Beijing JIANZHU JIEGOU XUEBAO [JOURNAL OF BUILDING STRUCTURES] in Chinese Vol 2 No 2, 5 Apr 81 pp 10-22

TEXT OF ENGLISH ABSTRACT: A new fundamental method for formulating bending plate elements, the quasi-conforming element method, is presented in this paper. All the elements formulated according to this method are assured to be convergent in the analysis. Moreover, this method is simple, easy to use and requires less computation.

The stiffness matrices of three types of bending plate elements are given in explicit form in the paper.

AUTHOR: LIN Yuankun [2651 0337 0981]
HONG Xixin [3163 1585 0207]

ORG: Both of the Fujian Design Institute of Light Industry

TITLE: "A Study and Practice of V-shaped Folded Plates for One-story Factory Buildings"

SOURCE: Beijing JIANZHU JIEGOU XUEBAO [JOURNAL OF BUILDING STRUCTURES] in Chinese Vol 2 No 2, 5 Apr 81 pp 23-33

TEXT OF ENGLISH ABSTRACT: This paper describes the design of a single span one-story factory building in which reinforced concrete precast in-situ V-shaped folded plates were used for roofs and walls. Two computation methods were presented, i.e., a single rectangular bent with hinged connection at the top of the wall and the other as a spatial structure. Measurements of stresses and strains under loads were made and the data obtained were compared with the computed results. Some discussions were also given in the paper.

AUTHOR: LIU Dahai [0491 1129 3189]
ZHONG Xigen [6945 6932 2704]
YANG Cuiru [2799 5050 1172]

ORG: All of the Northwest Building Design Institute

TITLE: "Behavior of Infilled Frame under Cyclic Loading"

SOURCE: Beijing JIANZHU JIEGOU XUEBAO [JOURNAL OF BUILDING STRUCTURES] in Chinese Vol 2 No 2, 5 Apr 81 pp 34-44

TEXT OF ENGLISH ABSTRACT: In the designing of brick infilled frame structures, the problem arises as to what values should be used for the rigidities and bearing capacities of the composite structure and its component parts--the frame and the infilling walls. Based on a study and comparison of experimental data domestic and abroad on the behavior of infilled frames under lateral loading, an attempt is made in this paper to elucidate the following points relevant to the design of infilled frame structures:
1. An overall and quantitative description of the structure under cyclic loading.
2. The evaluation of "effective" rigidities and bearing capacities of the structure and its component parts needed for the determination of the natural period and seismic stresses.
3. The proposal of a simplified procedure aimed to reduce computation work.

AUTHOR: YIN Zhilin [3009 5347 7207]

ORG: First Design Institute, First Ministry of Machine Building

TITLE: "Strength of the Reinforced Concrete and Prestressed Concrete Members under Combined Action of Tension, Moment and Torsion or Compression, Moment and Torsion"

SOURCE: Beijing JIANZHU JIEGOU XUEBAO [JOURNAL OF BUILDING STRUCTURES] in Chinese Vol 2 No 2, 5 Apr 81 pp 45-57

TEXT OF ENGLISH ABSTRACT: Under loading conditions, the lower chord of a girder truss is subjected to the combined action of prestressed compression, large axial tension, moment, shear and torsion, while the upper chord is subjected to the combined action of axial compression, moment, shear and torsion. The analysis of the results of five bottom loaded trusses, two top loaded trusses and 10 beam models subjected to compression, moment and torsion shows that the calculation of such members by the formula of the torsional strength of the flexure torsion members in the current code (TJ 10-74) and the principle of superposition are not adaptable, otherwise the results would be too safe. Practical formulas for computing the torsional strength considering the combined action of the above-mentioned forces are presented. Both the calculated and the test results are in good agreement.

AUTHOR: WANG Baozhen [3769 1405 3791]
ZHANG Kuanquan [1728 1401 2938]

ORG: Both of Sichuan Institute of Building Research

TITLE: "Experimental Research on the Calculating Method of Built-in Fittings"

SOURCE: Beijing JIANZHU JIEGOU XUEBAO [JOURNAL OF BUILDING STRUCTURES] in Chinese Vol 2 No 2, 5 Apr 81 pp 58-66

TEXT OF ENGLISH ABSTRACT: To evaluate the problems existing in the calculation of built-in fittings in reinforced concrete structures, 75 series of tests consisting of 212 specimens of various forms were made. Based on the "shear-friction" theory used in reinforced concrete and test data, the formulas for calculating anchor reinforcement of built-in fittings subjected to shear, bending, tension combined with shear and bending combined with shear are presented.

In comparison with the formulas given in the existing design manual, the proposed formulas present a more clear conception and simpler calculation in good agreement with the test data.

AUTHOR: HONG Jianguo [3163 1696 0948]

ORG: Eighth Design Institute, Ministry of Chemical Industry

TITLE: "Calculation of the Internal Stresses in Ring Foundation under Vertical Load"

SOURCE: Beijing JIANZHU JIEGOU XUEBAO [JOURNAL OF BUILDING STRUCTURES] in Chinese Vol 2 No 2, 5 Apr 81 pp 67-76

TEXT OF ENGLISH ABSTRACT: In this paper, the foundation bed is taken as a semi-elastic body and elastic theory is used to derive the settlement equations for any point on the superficies when a vertical uniform load is applied to a rectangular area c x b on the superficies. The ring foundation is divided into several parts equal in length. According to the deformation compatibility equations at the ends of each part and the statical equilibrium equations of the parts, the general equations of the ring foundation for the internal stresses, subsoil reactions and settlements are established.

The results obtained from this proposed method are more accurate than those obtained by the method considering the subsoil reactions as uniformly distributed.

9717
CSO: 4009/240

ELECTRONICS

AUTHOR: CHEN Miaohai [7115 5379 3189]

ORG: None

TITLE: "General Discussion of Photoelectron Antagonism Technology"

SOURCE: Beijing DIANZI KEXUE JISHU [SCIENCE AND TECHNOLOGY OF ELECTRONICS] in Chinese No 4, 81 pp 2-6

ABSTRACT: Photoelectron technology combines optics and electronics and involves the 3 aspects of ordinary optics, infrared, and laser. Weapons designed on the basis of photoelectronics include photoelectronic guidance, tracking, and control systems, photoelectronic reconnaissance and remote sensing equipment, photo-communication, and optical information processing systems, and laser heat weapons. The common characteristics of these weapons are the fact that their operating frequency is in the light wave band, in a range of about 10^{12} - 5×10^{16} Hz, with a wavelenght in the range of 0.3mm - 60 Å. Aside from laser, most of these photoelectronic equipment do not emit electromagnetic wave in themselves. Some of these are still in the research stage, while many have already been operative. Photoelectron antagonism technology includes ways to destroy or weaken the efficiency of photoelectronic weapons of the opponent as well as means of eliminating their harmful effects. In separate descriptions of each category, samples used in the paper are all USA makes.

AUTHOR: ZHANG Yongkang [1728 3057 1660]

ORG: None

TITLE: "Thermoelectron Power Generation and Thermionic Converter"

SOURCE: Beijing DIANZI KEXUE JISHU [SCIENCE AND TECHNOLOGY OF ELECTRONICS] in Chinese No 4, 81 pp 7-10

ABSTRACT: Presently, most thermal energy conversion processes to produce electricity are complicated. It is always necessary to have intermediate steps of changing heat energy into the functional energy of steam or the mechanical energy of turbine, etc. The efficiency is, therefore, low. There are 3 types of direct conversion: thermoelectricity (about 10 percent efficiency), magnetofluid power generation (about 40 percent efficiency) and thermoelectron [negative thermion] power generation (theoretically, the efficiency of thermionic converter may reach above 40 percent.) If thermionic converter is linked with steam or other thermal energy source, the total efficiency may reach about 60 percent. Technical problems of thermionic converters and the prospect of their application in space technology and in ground surface power generation are introduced.

AUTHOR: KE Wei [2688 0251]

ORG: Kaifeng Institute of Computer Technology Research

TITLE: "A Type of Automatic Answer Scheme in the DJS-130 Electronic Computer Linkage System"

SOURCE: Beijing DIANZI KEXUE JISHU [SCIENCE AND TECHNOLOGY OF ELECTRONICS] in Chinese No 4, 81 pp 29-30, 47

ABSTRACT: As applications of computers become more extensive, forms of application also increase. Aside from batch-processing, real-time, an time-sharing, the current development is in the network direction so that the computer resources may be enjoyed by many. The first problem in this form of application is the linkage and control between the terminal and the computer and among computers. The linkage may take the form of special line, exchange line, or others. If the form of telephone exchange line is adopted, the targets and the quantity of communication are never certain. In order that the computer center may call or release the data link [tie-link] from the telephone line, the author and colleagues established the DJS-130 computer linkage system in telephone exchange lines and provided it with an automatic answer device to enable the computer of the system to check the multiple-line long distance telephone system to call or cut off the data link. The work principle and the control process of the automatic answer device are described.

AUTHOR: YU Huayang [0151 5478 2254]

ORG: None

TITLE: "Electron Balance Type Totally Automatic Tracking Device for Solar Energy Steam Boiler"

SOURCE: Beijing DIANZI KEXUE JISHU [SCIENCE AND TECHNOLOGY OF ELECTRONICS] in Chinese No 4, 81 pp 33-34

ABSTRACT: Most installations for solar energy utilization have to be made to follow the direction of the sun. The author and colleagues made an automatic tracking device. It has been attached to a solar energy steam boiler. Its operation in these 2 years is very satisfactory. The tracking device is composed of an optical sensor,an amplifier, a relay control circuit, and an executive device. The executive device is made of 2 motors to enable the refracting mirrors to rotate on a vertical and a horizontal axis in a compound movement following the position of the sun. The structure of this tracking device is explained.

6168
CSO: 4009/238

AUTHOR: ZHANG Baokang [1728 0202 1660]

ORG: Aerial Remote Sensing Geology Team, Hunan Bureau of Geology

TITLE: "A Discussion on Application of Aeromagnetic Data in the Prognostication of Magmatic Hydrothermal Deposits"

SOURCE: Beijing WUTAN YU HUATAN [GEOPHYSICAL AND GEOCHEMICAL EXPLORATION] in Chinese Vol 5 No 2, 81 pp 82-85

ABSTRACT: Experiments have proved that heating may cause nonmagnetic ores such as hermatite, limonite, and clay to become magnetic. Magnetism of naturally magnetic ores is formed in the cooling process from a high tenerature to a low temperature, and the magnetism is relatively permanent. Unless the temperature is sufficiently high to change the molecular structure of the ore, the experimentally created magnetism will last several months to several years only. Based upon these facts, the various magnetic ores in rocks are believed to be basically formed by either magmatic or metamorphic actions and aeromagnetic anomalies may thus be used to locate hydrothermal deposits in regions where the crystalline bedrocks are not exposed and the overlaying strata are basically not magnetic. Characteristics of aeromagnetic anomalies, the controlling action of faults, and the possibility of using aeromagnetic data, in combination with data of other geophysical and geochemical techniques, to locate magmatic hydrothermal deposits are explained.

AUTHOR: WANG Jinrong [3769 6855 2502]

ORG: Geophysical Prospecting Brigade, Zhejiang Bureau of Geology

TITLE: "Some Preliminary Knowledge of the Shape and Geological Significance of the Mohorovičić Discontinuity in Zhejiang Province"

SOURCE: Beijing WUTAN YU HUATAN [GEOPHYSICAL AND GEOCHEMICAL EXPLORATION] in Chinese Vol 5 No 2, 81 pp 86-92

ABSTRACT: Based upon the gravitational data of points on 10 closed circles in the gravitational network of the province and the observed data of the gravitational profile of some parts of the province, a gravity anomaly map of the province is compiled for the purpose of clarifying the basic picture of gravitational field within the province. The data are processed to produce an outline of the Mohorovičić discontinuity. Combined with the condition of distribution of the known points of mineral deposits, the paper analyzes, in general terms, the principle of ore distribution and the regional geological structure in an effort to predict regions of prospective mineralization from a long range point of view.

5246
CSO: 4009/245

AUTHOR: None

ORG: None

TITLE: "The Second Board of Directors Meeting of China Association of Printing Technology Held in Beijing"

SOURCE: Beijing YINSHUA JISHU [PRINTING TECHNOLOGY] in Chinese No 2, 81 p 2

ABSTRACT: The Second Board of Directors meeting of China Association of Printing Technology was held 26-27 Feb 81 in Beijing, chaired by the Deputy Chairman WANG Fangzi [3769 0119 1311]. Many valuable opinions concerning the work plans of 80 and 81 were presented by many members of the board. The 81 work plan was passed after discussion. In a speech delivered by the Chairman of the Board Wang Yi [3769 4135] every member of the board was asked to write an article, make a report, present a historical or literary document concerning printing, offer a suggestion, or do any other job to help the association. Wherever conditions permit, establishment of local associations of printing technology should be promoted. The 1981 Yearbook of Printing and the association's trade magazine YINSHUA JIE (temporary name) are to be created. The first meeting of the editorial committee of the yearbook was held during the conference to discuss the editorial plans for the yearbook.

AUTHOR: LI Youjin [2621 1429 6855]

ORG: Printing Shop, Renmin Artistic Publications

TITLE: "Properties of Chinese Make QFC Intense Light Source Color Separation Enlarger and Its Application"

SOURCE: Beijing YINSHUA JISHU [PRINTING TECHNOLOGY] in Chinese No 2, 81 pp 17-18

ABSTRACT: The QFC intense light source enlarger is the product of Chungqing Printing Machinery Plant. It has 3 lenses and can enlarge a maximum of 9 times the original and produce 2-3 sets of color separation a day. It is relatively inexpensive, only 50,000 yuan, while an imported enlarger costs generally about 700,000 yuan. During the first half a year after the enlarger was delivered, no one was eager to try it due to lack of confidence. After it was finally installed in Apr 79, it has performed normally. To date, its properties are basically stable.

6248
CSO: 4009/264

Seismology and Geology

AUTHOR: WU Kaitong [0702 7030 4827]
WU Peiling [0702 1014 5376]
LI Ziqiang [2621 5261 1730]
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ORG: WU Kaitong and WU Peiling both of the Center of Earthquake Analysis and Prediction, National Bureau of Seismology; LI, CHEN, CAO and TIAN all of the Institute of Geophysics, National Bureau of Seismology; JIN of Hebei Seismological Bureau

TITLE: "The Great Tangshan Earthquake and Its Foreshocks and Aftershocks"

SOURCE: Beijing DIZHEN DIZHI [SEISMOLOGY AND GEOLOGY] in Chinese Vol 3 No 1, 1981 pp 1-9

TEXT OF ENGLISH ABSTRACT: This paper deals with the determination of seismic parameters of the Tangshan earthquake and its geological background, and also discusses characteristics of microshocks before the main shock, such as seismic gap, shock-concentration-quiescence, b-value decrease and the strip-distribution of shocks, etc.

According to the surface rupture trend caused by this earthquake, the initial

[Continuation of DIZHEN DIZHI Vol 3 No 1, 1981 pp 1-9]

radiation pattern of P-waves, the vertical deformation both before and after the main shock and the distribution of aftershocks, etc., we supposed that the Ms 7.8 earthquake was probably a result of the horizontal dextral movement of a NE trending fault, and the Ms 7.1 earthquake was caused by the horizontal sinistral displacement of nearly SN-running Luanhe fault which was dragged by the NE fault.

From the characteristics of space and time distribution of aftershocks in the Tangshan area, the focal rupture process and its influence on the aftershocks were discussed in this paper. Finally, it is suggested that the occurrence time of the Tangshan earthquake was probably associated with the current astronomic conditions.

AUTHOR: MA Jin [7456 3866]
XU Xiuqin [6079 4423 3830]
ZHANG Botao [1728 3258 3447]
LIU Tianchang [0491 1131 2490]
WU Xiuquan [0702 4423 3123]
WANG Baosheng [3769 1405 3932]

ORG: All of the Institute of Geology, National Bureau of Seismology

TITLE: "Experimental Studies of the Process of Fracture and Acoustic Emission in a Fault Zone"

SOURCE: Beijing DIZHEN DIZHI [SEISMOLOGY AND GEOLOGY] in Chinese Vol 3 No 1, 1981 pp 11-17

TEXT OF ENGLISH ABSTRACT: From the features of fracture and acoustic emission and the stress-strain behavior, this paper indicates that the activity of a fault zone depends on the angle of the fault plane with soft sandwich and the axis of principal compressive stress. Our experiments provide evidence that as this angle is larger than 45°, the fracture process has three stages, and before the main shock there occurred a number of foreshocks, with an apparent dislocation taking place within the fault zone and its surroundings. On the other hand, if the angle is smaller than 45°, these phenomena would disappear.

AUTHOR: None

ORG: United Group of Focal Mechanisms

TITLE: "Study of Recent Tectonic Stress Field in the Jiangsu-Shandong-Anhui-Henan Region from the Focal Mechanism Solutions"

SOURCE: Beijing DIZHEN DIZHI [SEISMOLOGY AND GEOLOGY] in Chinese Vol 3 No 1, 1981 pp 19-28

TEXT OF ENGLISH ABSTRACT: Based on the statistical studies of focal mechanism solutions of 37 moderate-small earthquakes (Ms = 2.1 - 6.0) during the period from 1973 to 1977 in the Jiangsu-Shandong-Anhui-Henan region, the preferred principal compressive stress of the recent tectonic stress field is NEE (about 76°) and the tensile stress is NNW (about 344°). Considering that both the long axes of isoseismals for some moderate-small shocks and the Late Tertiary faults are characterized by a NNE trend in predominance, we inferred the newly-formed seismic rupture to be successive. Finally, this paper discusses the difference between the recent tectonic stress fields in its northern and southern parts.

AUTHOR: CHENG Shaoping [4453 4801 1627]
RAN Yongkang [0373 0516 1660]

ORG: Both of the Institute of Geology, National Bureau of Seismology

TITLE: "Hutuo River Terraces in the Taihang Canyon Section and Quaternary Tectonic Movement"

SOURCE: Beijing DIZHEN DIZHI [SEISMOLOGY AND GEOLOGY] in Chinese Vol 3 No 1, 1981 pp 29-39

TEXT OF ENGLISH ABSTRACT: The investigation of river terraces is an effective way to explain the neotectonic movements. The data obtained by a detailed survey of Hutuo River terraces in the Taihang canyon section show that there are four terraces in this river section, reflecting four intermittent uplifted movements since the Quaternary. These terraces were offset and deformed by the Jiazhiwan fault, along which the uplifted Xizhou-Taihang fault block was tilted. It is suggested that the northern segment of the Taihang fault block is still following the nature of Pliocene movements, and the present regional tectonic stress state does not show any essential changes.

AUTHOR: HE Yongnian [0149 3057 1628]
LIN Chuanyong [2651 0278 0516]

ORG: Both of the Institute of Geology, National Bureau of Seismology

TITLE: "On the Texture and Fabric of Some Lherzolite Nodules in Cainozoic Basalt from Eastern China"

SOURCE: Beijing DIZHEN DIZHI [SEISMOLOGY AND GEOLOGY] in Chinese Vol 3 No 1, 1981 pp 41-50

TEXT OF ENGLISH ABSTRACT: The ultramafic nodules widely distributed in Cainozoic basalt in eastern China are regarded as fragments of the upper mantle that were brought up to the ground surface by basaltic magma. It is suggested that the study of this kind of nodules would offer some direct information about the upper mantle. The textures of some spinel lherzolite nodules collected from some regions in eastern China are discussed in this paper. Three main types of texture can be distinguished, i.e., coarse granular, porphyroclastic and granuloblastic. Their fabrics were also analyzed, and the preferred orientation of minerals indicates that the coarse granular type is lacking in orientation, whereas the porphyroclastic type has distinct orientation, and the latter's fabric feature is followed by the granuloblastic type with some variation. Thus, the coarse granular-porphyroclastic-granuloblastic transitional sequence has been established. Moreover, the textures and fabrics of the Alpine type of peridotite from a suite of ophiolite formed by emplacement are comparable with these kinds of nodules, enabling us to further infer their mantle origin.

AUTHOR: YAN Fuhua [0917 1381 5478]
YE Yongying [5509 3057 5391]
MAI Xueshun [7796 1331 5293]
LIU Yuexia [0491 4727 7209]

ORG: All of the Institute of Geology, National Bureau of Seismology

TITLE: "On the Environment and Geological Age of Two Ores in the Beijing Region from Sporo-pollen Analysis"

SOURCE: Beijing DIZHEN DIZHI [SEISMOLOGY AND GEOLOGY] in Chinese Vol 3 No 1, 1981 pp 51-65

TEXT OF ENGLISH ABSTRACT: The two peat sections are situated in Xiaowangzhuang, Yanqing County, and Xinlitun, Haidian district, respectively.

Many pollen grains of arboreous, shrubs and herbaceous plants are found in the peat sediments. They belong to the genera *Pinus*, *Quercus*, *Betula*, *Ulmus*, *Tilia*, *Ephedra*, *Artemmisia*, etc., and families Chenopodiaceae, Gramineae, Cyperaceae, Compositae, etc.

Three vegetation phases from the lower to upper parts of the sections may be distinguished by the pollen analysis. The lower part of the sections represents a coniferous forest phase, mainly consisting of *Pinus* or the coniferous-broad forest phase of *Pinus* and *Betula*, while the middle and upper parts represent the

[Continuation of DIZHEN DIZHI Vol 3 No 1, 1981 pp 51-65]

coniferous-broad forest phase, mainly consisting of *Pinus*, *Quercus*, *Betula*, *Ulmus* and *Tilia* and coniferous forest phase of *Pinus*, respectively.

The results of pollen analysis show that the climate was changing during the formation of the peats. In the early stage the prevailing climate was warmer and drier, in the middle stage it was warm and moist, and in the late stage a cooler and drier climate dominated.

Based on the polynological date C^{14} age determination, the geological ages of two peat ore sections are described as the Early Holocene for the lower part, and the Middle and Upper Holocene for the middle and upper parts, respectively.

AUTHOR: DING Menglin [0002 1125 7792]

ORG: Institute of Geology, National Bureau of Seismology

TITLE: "Some Paleoseismic Evidence in the North China Region"

SOURCE: Beijing DIZHEN DIZHI [SEISMOLOGY AND GEOLOGY] in Chinese Vol 3 No 1, 1981 pp 67-74

TEXT OF ENGLISH ABSTRACT: In this report some evidence of ancient earthquakes found in the north China region are presented as follows:
1. The ruins of ancient cities in the Hang dynasty destructed by earthquakes which occurred in the area northwest of Dengkou County, Nei Monggol Autonomous region; 2. The offset of the Great Wall and fault scarps by the ancient earthquakes in the Hongguozigou area northwest of Pinglo County, Ningxia Autonomous Region; 3. The paleoseismic faults and liquefaction and deformation of sandy ground in the Guchenzi area, Zhongning County, Ningxia Region; 4. Landslide zones in loess caused by the ancient earthquakes in the Tiansnui-Baoji-Changxing region; 5. Seismic fissures and rock falls in Haicheng County, Liaoning Province; 6. The folds and deformation of lacustrine diatomite layers by earthquakes in Linqu County, Shandong Province; 7. Paleoseismic fissures in Xingyi County, Jiangsu Province. These results are of significance in regional seismic evaluation.

AUTHOR: WEI Bolin [7614 0130 2651]

ORG: Guangdong Bureau of Seismology

TITLE: "Focal Stress Field and Tectonic Stress Field of the Xinfengjiang Reservoir Induced Earthquakes"

SOURCE: Beijing DIZHEN DIZHI [SEISMOLOGY AND GEOLOGY] in Chinese Vol 3 No 1, 1981 pp 75-79

TEXT OF ENGLISH ABSTRACT: The focal stress field of the Xinfengjiang earthquakes shows that the T-axis constantly trends toward the NNE and is nearly horizontal, but the P-axis rotates from 0° to 180° in a vertical plane perpendicular to the T-axis. Under the N-S horizontal tectonic compression, the focal stress field is induced by a left-lateral transform fault at Heyuan resulting from the relative sliding between the rock mass in the reservoir area and its southern side at different rates.

9717
CSO: 4009/202

AUTHOR: JIN Liang [6855 5328]

ORG: None

TITLE: "The Submarine's 'Disappearing Act'"

SOURCE: Beijing JIANCHUAN ZHISHI [KNOWLEDGE OF SHIPS] in Chinese No 1, Jan 81 pp 12-13

ABSTRACT: Submarines which have been detected by sonar and face imminent attack have several methods of avoiding it. The first is the gas curtain shell, a combination of calcium hydride, sodium soaps and other substances which when detonated in the water creates a cloud of bubbles that screen active sonar and mask the noise made by the submarine. Although the bubble curtains considerably resemble submarines in their sonar behavior, they can be distinguished by the irregularity of bubble production. Submarines can launch interference devices which maintain themselves at a given depth and produce signals resembling those given out by a submarine. The main weak point of these devices is the fact that they are stationary. But submarines can also launch decoys from their torpedo tubes. These devices will move on a preset course as well as emitting decoy signals to confuse enemy sonar. These devices are generally used only in case of extreme distress, because there is a possibility that they may actually make detection easier in some cases.

AUTHORS: YAO Jiajin [1202 1367 3866], QING Quan [2532 1557]

ORG: None

TITLE: "The 'England's' Sub Chasing Feat"

SOURCE Beijing JIANCHUAN ZHISHI [KNOWLEDGE OF SHIPS] in Chinese No 1, Jan 81 pp 18-20

ABSTRACT: In May 1944, a Japanese submarine was bound for Bougainville to take food to the encircled Japanese forces there. The US Navy intercepted a radio communication about the mission and dispatched the sub chaser England, which sank the submarine with Hedgehog depth charges. Later in May, 7 Japanese submarines implemented the A-GO plan in which they established the NA patrol line between Manus Island and Truk in the hope of destroying US squadrons. Between 22 and 30 May the England sank 5 of the 7 submarines with depth charges, thus gaining lasting fame.

AUTHOR: DAI Yaonan [2071 3613 0589]

ORG: None

TITLE: "Configurations of Modern Submarines"

SOURCE: Beijing JIANCHUAN ZHISHI [KNOWLEDGE OF SHIPS] in Chinese No 2, Feb 81 pp 6-7

ABSTRACT: There are two basic types of submarine configurations, the linear type and the drop-shaped type. The linear type is used primarily for diesel-powered submarines and maximizes surface navigation characteristics, while the drop-shaped type is used primarily for nuclear submarines and maximizes underwater characteristics. The linear type generally has a pointed to straight bow with an oval cross section (the shape is affected by the presence of torpedo tubes and sonar installations), widens to a circular cross section amidships and then changes to an "inverted gourd" shape near the tail. Conning towers may be rather large, holding large amounts of equipment. The drop-shaped submarine has a circular cross section throughout. The nose is rounded and the tail tapers to a point, in contrast with the linear submarine, whose tail is often box-shaped, although other configurations are possible. The conning towers of nuclear submarines are made small to reduce drag in underwater operation.

AUTHOR: WANG Gang [3769 6921]

ORG: None

TITLE: "External Coatings of Fighting Ships"

SOURCE: Beijing JIANCHUAN ZHISHI [KNOWLEDGE OF SHIPS] in Chinese No 2, Feb 81 p 7

ABSTRACT: The coatings of ships perform several functions. Antirust paint protects the iron hulls of ships from corrosion by the oxygen in sea water and the air, and may perform this function successfully for several decades. Since barnacles and other marine life growing on the hulls of ships reduce their speed, antifouling paint which contains poisonous substances can be used to prevent barnacle growth. Ships are generally painted blue-gray, since this is the color most difficult for enemy ships to detect at sea. Inside the ships, the different piping systems are painted different colors so that in the event of battle damage it is possible to determine immediately which piping has been damaged: fresh water systems are painted light gray, high pressure systems dark blue, diesel fuel systems brown and the like.

8480
CSO: 4009

AUTHOR: QIU Jifu [6726 0679 1133]

ORG: None

TITLE: "Trend of Development of Telephone Switching Technology in Foreign Countries--Digital Switching"

SOURCE: Shanghai DIANXIN KUAIBAO [TELECOMMUNICATIONS INFORMATION] in Chinese No 1, Jan 81 pp 22-40

ABSTRACT: In the past several years, with respect to telephone switching technology, aside from the application of stored program control, the development in foreign countries is toward digital switching. The 80's will be a period of transition from analog switching to digital switching. Based upon foreign information, especially literatures of the 1979 International Switching Conference and product descriptions, this paper provides a general introduction of the trend of development of major foreign countries, including the USA, France, England, W. Germany, Japan, Sweden, Canada, Holland, and international systems. A table is included outlining the digital switching system of each of these countries. Finally, the merits and demerits of digital switching systems are discussed.

AUTHOR: HUA Zhengde [5478 2973 1795]

ORG: None

TITLE: "Transmitting Television Telephone Wide-band Signals on Urban Telephone Cables"

SOURCE: Shanghai DIANXIN KUAIBAO [TELECOMMUNICATIONS INFORMATION] in Chinese No 2, Feb 81 pp 32-36

ABSTRACT: Transmitting television telephone signals is a major problem in the process of establishing an image communication network and the best solution is to utilize the existing urban telephone cables to transmit the wide-band signals. The cost of establishing such a network may thus be greatly reduced. This paper introduces the problems and experiences of 2 experiments carried out in Nov 78 and Sep 79 on a line from the Shanghai Telephone Bureau to relay lines and users' lines of various distances and from the Shanghai Post-telecommunications Hospital to the First Research Institute of the Ministry of Post and Telecommunication of a distance of 3.2 km, respectively. The wide-band signal analog balance technique described in the paper has been successfully applied in a 1 MHz remote control television telephone system.

AUTHOR: DU Jiazhen [2659 0857 3791]

ORG: None

TITLE: "Introducing the Condition of the GAS 5 Group in the Final Conference of the 1977-1980 Research Period of CCITT"

SOURCE: Shanghai DIANXIN KUAIBAO [TELECOMMUNICATIONS INFORMATION] in Chinese No 2, Feb 81 pp 45-48

ABSTRACT: CCITT (Consultant Conference of International Telephone and Telegraph) is a specialty organization of the International Telegraphic Union (ITU) and belongs also to the United Nations, with its headquarters in Geneva. Its membership includes representatives of 154 nations and about 200 private organizations, with about 100 scientific or industrial organizations participating in related research groups as well. Generally, the conference meets once every 4 years. which constitute a research period. The GAS 5 Group is the Fifth special independent research group, chaired by M.H. Lonnegueue of France. The task of the group is to compile a handbook on the economic condition and development relating to communications. The book, dividing into 6 parts and containing valuable reference data, has not yet been published. The contents of these 6 parts are briefly outlined in the paper.

6168
CSO: 4009/256

AUTHOR: ZHU Lunyao [2612 4858 5069]

ORG: None

TITLE: "Properties of Various Models of 4GHz High Frequency Apparatuses Compared"

SOURCE: Beijing DIANXIN JISHU [TELECOMMUNICATION TECHNOLOGY] in Chinese No 4, Apr 81 pp 23-25

ABSTRACT: The microwave receivers and transmitters in frequency bands from 3800 MHz to 4200MHz (to be called high frequency apparatuses in this paper) made by the Post-Telecommunication 506 Plant now come in 3 models, all capable of transmitting 960 lines of analog telephony or one line of television (image signals and audio signals.) The first product of the early 70's is the WZ960-01B model, commonly called the Model I. In the middle 70's, the 4 WG-1 and 4 WG-2 models appeared and both are commonly called the Model II. Later, the technique of Model II is used to improve some Model I apparatuses that are already in service to bring about the improved WZ960-01B Model. Moreover, a few receivers and transmitters have also been produced by utilizing the technique of the Model II according to the Model I indices; these are very few in number and do not technically form an independent model. This paper introduces the major technical differences of the 3 types: the Model I, the Model II, and the Improved Model I. A table is included to list various property indices of the three, side by side for comparison.

AUTHOR: YANG Mingzuo [2799 2494 0146]

ORG: None

TITLE: "Open-wire High Twelve-Line Carrier Wave Telephone Equipment"

SOURCE: Beijing DIANXIN JISHU [TELECOMMUNICATION TECHNOLOGY] in Chinese No 4, Apr 81 pp 28-29

ABSTRACT: Open-wire high twelve-line carrier wave telephone equipment is a twelve-line carrier wave telephone equipment added to the overhead open-wire twelve-line carrier wave telephone already in service. Due to the fact that its line transmission frequency is higher than ordinary open-wire twelve-line carrier wave telephone equipment, it is called open-wire high twelve-line. Based upon the actual experiences of some provinces, on the new 8 or new 4 types of copper wires, a certain number of high twelve-lines can be added under the condition of not changing the original amplification distance. This is currently one of the economical and fast ways of developing communication within a province. Details of applying this technique and essential problems are explained.

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